

**DISTRIBUTION STATEMENT A**  
Approved for Public Release  
Distribution Unlimited



**US Army Corps  
of Engineers®**

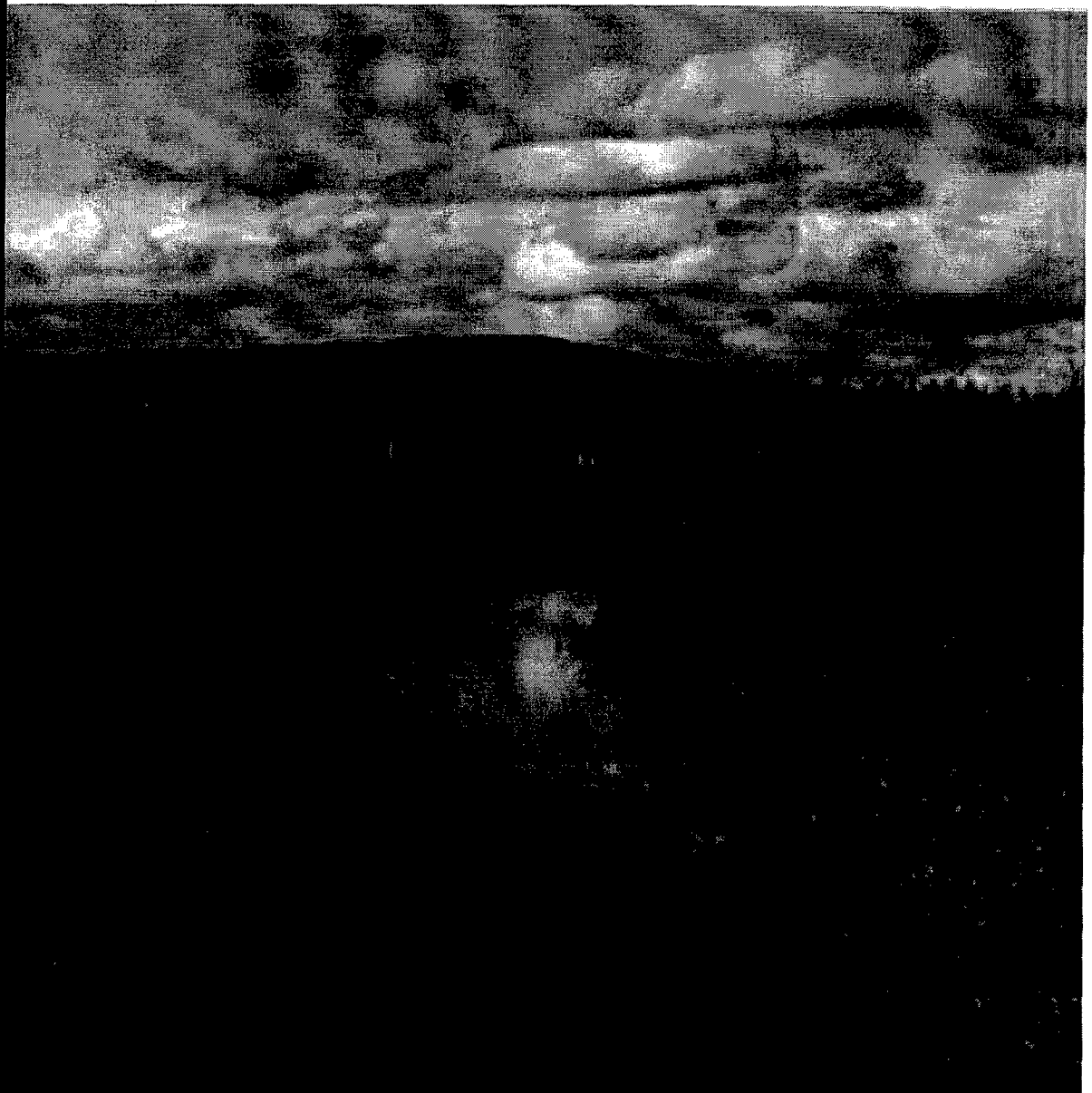
Cold Regions Research &  
Cold Regions Research &  
Engineering Laboratory

19990923 033

## **An Ecological Land Survey for Fort Wainwright, Alaska**

M. Torre Jorgenson, Joanna E. Roth, Martha K. Raynolds,  
Michael D. Smith, Will Lentz, Allison L. Zusi-Cobb, and  
Charles H. Racine

September 1999



**Abstract:** An ecological land survey (ELS) of Fort Wainwright land was conducted to map ecosystems at three spatial scales to aid in the management of natural resources. In an ELS, an attempt is made to view landscapes not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts that can provide a consistent conceptual framework for ecological applications. Field surveys at 109 sites along 11 toposequences, and at an additional 131 ground-reference locations, were used to identify relationships among physiography, geomorphology, hydrology, permafrost, and vegetation. The association among ecosystem components also revealed effects of fire and geomorphic processes, such as groundwater discharge, floodplain develop-

ment, permafrost degradation, and paludification. Ecosystems were mapped at three spatial scales. Ecotypes (1:50,000 scale), delineated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecosctions (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and physiography. Development of the spatial database within a geographic information system will facilitate numerous management objectives such as wetland protection, integrated-training-area management, permafrost protection, wildlife management, and recreational area management.

**Cover:** Bull moose in Lowland Fen Meadow Ecotype on the Tanana Flats, Ft. Wainwright, Alaska. (Photo by C. Racine.)

**How to get copies of CRREL technical publications:**

Department of Defense personnel and contractors may order reports through the Defense Technical Information Center:

DTIC-BR SUITE 0944  
8725 JOHN J KINGMAN RD  
FT BELVOIR VA 22060-6218  
Telephone 1 800 225 3842  
E-mail help@dtic.mil  
msorders@dtic.mil  
WWW <http://www.dtic.mil/>

All others may order reports through the National Technical Information Service:

NTIS  
5285 PORT ROYAL RD  
SPRINGFIELD VA 22161  
Telephone 1 800 553 6847 or 1 703 605 6000  
1 703 487 4639 (TDD for the hearing-impaired)  
E-mail orders@ntis.fedworld.gov  
WWW <http://www.ntis.gov/index.html>

A complete list of all CRREL technical publications is available from

USACRREL (CEERD-IM-HT-HL)  
72 LYME RD  
HANOVER NH 03755-1290  
Telephone 1 603 646 4338  
E-mail techpubs@crrel.usace.army.mil

**For information on all aspects of the Cold Regions Research and Engineering Laboratory, visit our World Wide Web site:**  
<http://www.crrel.usace.army.mil>

[Go to contents page](#)



**US Army Corps  
of Engineers®**

Cold Regions Research &  
Engineering Laboratory

## **An Ecological Land Survey for Fort Wainwright, Alaska**

M. Torre Jorgenson, Joanna E. Roth, Martha K. Raynolds,  
Michael D. Smith, Will Lentz, Allison L. Zusi-Cobb, and  
Charles H. Racine

September 1999

Prepared for  
U.S. ARMY, ALASKA

Approved for public release; distribution is unlimited.

[Back to contents page](#)

## PREFACE

This report was prepared by M. Torre Jorgenson, Senior Scientist, Joanna E. Roth, Research Biologist, Martha K. Raynolds, Research Biologist, Michael D. Smith, Systems Analyst, Will Lentz, GIS Technician, and Allison L. Zusi-Cobb, GIS Technician, ABR, Inc., Fairbanks, Alaska, and Charles H. Racine, Ecologist, Geological Sciences Division, U.S. Army Cold Regions Research and Engineering Laboratory (CRREL), Hanover, New Hampshire.

Charles Collins, Dr. Lewis Hunter, Stephen Murphy, and Betty Anderson technically reviewed this report.

We would like to acknowledge the support of William Gossweiler, William Quirk, and Gary Larsen, Ft. Richardson, who provided funding for this project as part of the baseline studies for the Legislative Environmental Impact Statement. Pam Bruce of Ft. Wainwright helped coordinate logistics. James Walters, University of Northern Iowa, helped with the field work and did many of the soil stratigraphy descriptions. Erik Pullman performed some of the differential processing of GPS data. Stephen Murphy and Betty Anderson technically reviewed this report. Devonee Harshburger helped with the report production.

The contents of this report are not to be used for advertising or promotional purposes. Citation of brand names does not constitute an official endorsement or approval of the use of such commercial products.



## CONTENTS

<u>Preface .....</u>	<u>ii</u>
<u>Introduction .....</u>	<u>1</u>
<u>Study area .....</u>	<u>3</u>
<u>Methods .....</u>	<u>5</u>
Field survey .....	5
Classification .....	6
Classification and mapping .....	11
Ecosystem characteristics .....	46
Ecosystem dynamics .....	51
<u>Summary and conclusions .....</u>	<u>62</u>
<u>Literature cited .....</u>	<u>62</u>
<u>Abstract .....</u>	<u>85</u>

## ILLUSTRATIONS

### Figure

1. Interaction of interrelated state factors that control structure and function of ecosystems .....	2
2. Location of study area and survey transects for the ecological land survey of Fort Wainwright, central Alaska, 1998 .....	4
3. System for hierarchically classifying ecosystem components into integrated terrain units that explicitly denote ecosystem components and aggregating and simplifying these ITUs into ecotypes .....	9
4. Map of geomorphic classes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998 .....	16
5. Map of geomorphic classes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998 .....	17
6. Map of vegetation classes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998 .....	24
7. Map of vegetation classes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998 .....	25
8. Soil texture and cryostructures that were used in classifying stratigraphy of geomorphic units along toposequences, Ft. Wainwright, central Alaska, 1998 .....	26
9. Toposequence (transect 1) in the Willow Creek Lowlands illustrating geomorphology, surface form, vegetation, relative elevation,	

Figure

10. Toposequence (transect 2) in the Clear Creek Lowlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	27
11. Toposequence (transect 3) in the Willow Creek Lowlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	28
12. Toposequence (transect 4) in the Dry Creek Lowlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	28
13. Toposequence (transect 5-south) on the Wood River Buttes portion of the Tanana-Wood River Uplands and illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	29
14. Toposequence (transect 5-butte) on the Wood River Buttes portion of the Tanana-Wood River Uplands and illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, Alaska, central Alaska, 1998 .....	29
15. Toposequence (transect 5-north) on the Wood River Buttes portion of the Tanana-Wood River Uplands and illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, Alaska, central Alaska, 1998 .....	30
16. Toposequence (transect 6) in the Eielson-Tanana Floodplain illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	30
17. Toposequence (transect 7) in the French-Moose Creek Lowlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	31
18. Toposequence (transect 8-east) in the Chena-Salcha Highlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	31
19. Toposequence (transect 8-south) in the Chena-Salcha Highlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	32
20. Toposequence (transect 9) in the Chena-Salcha Highlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	32
21. Toposequence (transect 10) in the Chena-Salcha Highlands illustrating geomorphology, surface form, vegetation, relative	

## Figure

elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	33
22. Toposequence (transect 11) in the Wood River Lowlands illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998 .....	33
23. Map of ecotypes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998 .....	42
24. Map of ecotypes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998 .....	43
25. Map of ecodistricts within Ft. Wainwright, central Alaska, 1998 .....	47
26. Frequency of permafrost occurrence, and mean ( $\pm$ SD) surface organic matter depths and depth to gravel in ecotypes within Ft Wainwright, central Alaska, 1998 .....	52
27. Mean ( $\pm$ SD) pH (soil or water), electrical conductivity (EC), and water depths in ecotypes within Ft. Wainwright, central Alaska, 1998 .....	53
28. Generalized profile of ecological characteristics within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998 .....	55
29. Generalized profile of ecological characteristics on the Tanana Flats, Ft. Wainwright, central Alaska, 1998 .....	56
30. Permafrost distribution in the Yukon Maneuver Area based on permafrost characteristics of ecotypes, Fort Wainwright, central Alaska, 1998 .....	57
31. Permafrost distribution on the Tanana Flats based on permafrost characteristics of ecotypes, Fort Wainwright, central Alaska, 1998 ...	58
32. Distribution and extent of forest fires within Ft. Wainwright, central Alaska, 1998 .....	60

## TABLES

### Table

1. Coding system for the ecological land classification for Ft. Wainwright, central Alaska, 1998 .....	7
2. Differentiation of ecosystems at various scales. ....	8
3. Description of geomorphic units within Ft. Wainwright, central Alaska, 1998 .....	12
4. Areal extent of geomorphic units within the Yukon Maneuver Area and Tanana Flats portions of Ft. Wainwright, central Alaska, 1998 .....	15
5. Classification and description of vegetation types within Ft. Wainwright, central Alaska, 1998 .....	19
6. Areal extent of vegetation types within Yukon Maneuver Area and Tanana Flats portions of Ft. Wainwright, central Alaska, 1998 .....	23
7. Typical relationships among ecosystem components for ecosystems found within Ft. Wainwright, central Alaska, 1998 .....	34
8. Classification and description of ecotypes within Ft. Wainwright, central Alaska, 1998 .....	37

Table

9. Areal extent of ecotypes found within Ft. Wainwright, central Alaska, 1998 .....	41
10. Description of the physiography, geomorphology, hydrology, permafrost, and vegetation associated with ecodistricts and ecosub-districts mapped within Ft. Wainwright, central Alaska, 1998 .....	44
11. Mean cover (%) of the most abundant species within alpine and upland ecotypes at Ft. Wainwright, central Alaska, 1998 .....	48
12. Mean cover (%) of the most abundant species within lowland ecotypes at Ft. Wainwright, central Alaska, 1998 .....	50
13. Mean cover (%) of the most abundant species within riverine ecotypes at Ft. Wainwright, central Alaska, 1998 .....	51

## **An Ecological Land Survey for Fort Wainwright, Alaska**

M. TORRE JORGENSEN, JOANNA E. ROTH, MARTHA K. RAYNOLDS,  
MICHAEL D. SMITH, WILL LENTZ, ALLISON L. ZUSI-COBB, AND CHARLES H. RACINE

### **INTRODUCTION**

In response to the need for information on the natural resources on Fort Wainwright by the Integrated Training Area Management Program being implemented by the U.S. Army, we performed an ELS (ecological land survey) of land within the base's boundaries. This report presents the rationale and methods used to classify and map ecosystems on the base, describes the nature and dynamics of these ecosystems, and documents the structure of the GIS (geological Information system) databases used in mapping and aggregating ecosystems at several spatial scales.

In an ELS, an attempt is made to view landscapes not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts (Rowe 1961, Bailey 1980, 1996, Wiken and Ironside 1977, Driscoll et al. 1984). The goal of ELS, then, is to provide a consistent conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. To provide the information required for such a wide range of applications, an ELS involves three types of efforts: (1) an ecological land survey that inventories and analyzes data obtained in the field, (2) an ecological land classification that classifies and maps ecosystem distribution, and (3) an ecological land evaluation that assesses the capabilities of the land for various land management practices. Our emphasis in this report is on the ELS and classification efforts. A companion report evaluates some of the potential land evaluation applications, such as permafrost

distribution and sensitivity, disturbance regimes, and wildlife habitat use (Jorgenson et al., in prep.).

The structure and function of ecosystems largely are regulated along energy, moisture, nutrient, and disturbance gradients, and these gradients are affected by climate, physiography, soils, hydrology, flora, and fauna (Barnes et al. 1982, ECOMAP 1993, Bailey 1996). These ecosystem components can be viewed as state factors that affect ecological organization (Jenny 1941, Van Cleve et al. 1990, Vitousek 1994, Bailey 1996, Ellert et al. 1997) (Fig. 1a). Accordingly, we used the state factor approach to partition the variations in independent factors (e.g., climate, organisms, topography, parent material, and time) to facilitate ecosystem classification and mapping (Fig. 1a). While thematic maps of individual ecosystem components (e.g., geomorphology and vegetation) have their particular uses, this linking and aggregating of components into ecosystems with covarying climate, geomorphology, surface forms, hydrology, and biota can provide a spatial stratification that conveys a much broader range of information required for ecosystem management.

An ELS also involves the organization of ecosystem components at various scales (Wilken 1981, O'Neil et al. 1986, Bailey 1996, Klijn and Udo de Haes 1994) based on the recognition that the state factors operate within a hierarchy of differing spatial and temporal scales (Allen and Starr 1982, Delcourt and Delcourt 1988, Forman 1995). This hierarchical linkage reveals that smaller scale features, such as vegetation, are nested within

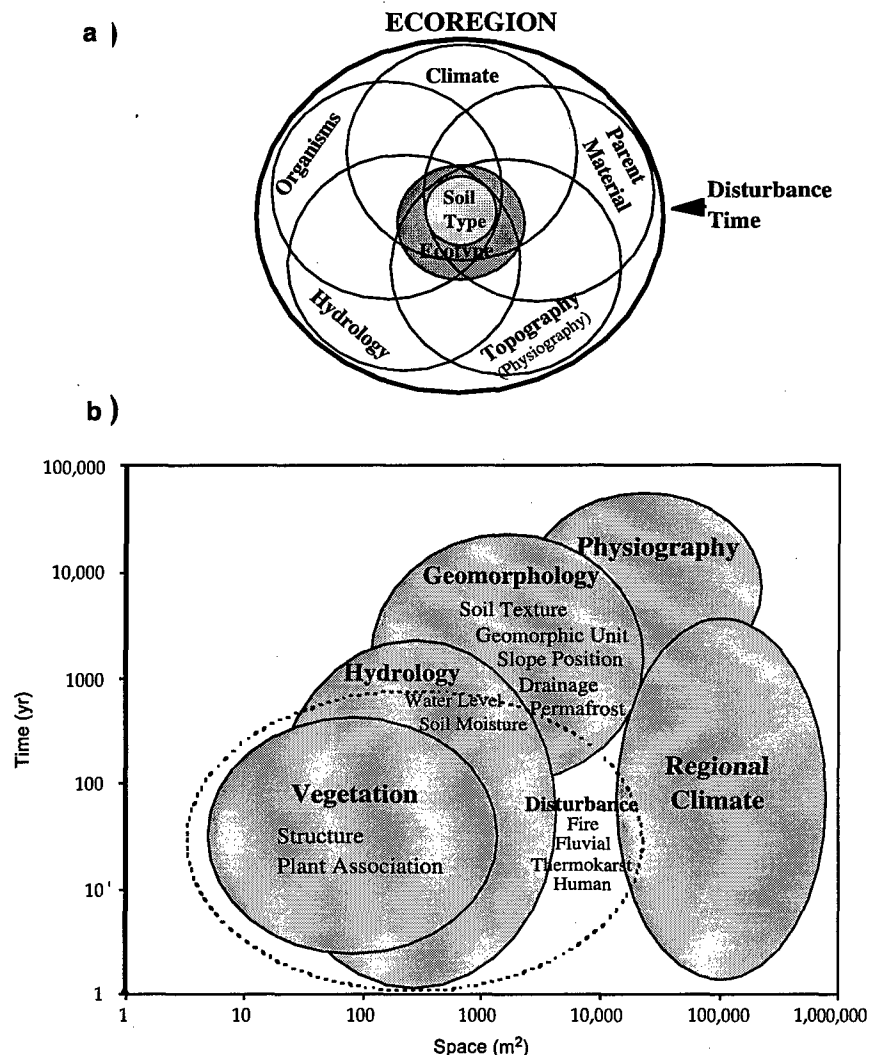


Figure 1. Interaction of interrelated state factors that control structure and function of ecosystems.

larger scale components, such as climate or physiography (Fig. 1b). The climate factor, particularly temperature and precipitation, globally accounts for the largest amount of variation in ecosystem structure and function globally (Walter 1979, Vitousek 1994, Bailey 1998). Physiography, or broad-scale landforms, with a characteristic geologic substrate, surface shape, and relief, are the boundary conditions that control the spatial arrangement and rate of geomorphic processes. Thus physiography affects the material (characteristic lithologies or soil texture) and energy flows that affect ecosystem development (Wahrhaftig 1965, Swanson et al. 1988, Bailey 1996). Soil moisture and hydrologic movement are critical factors in the water balance of plants and the availability of nutrients (Fitter and Hay 1987,

Oberbauer et al. 1989). Vegetation typically is the most important factor controlling the trophic structure of ecosystems because it controls primary productivity, and affects material and energy exchange, provides structure and energy for other trophic levels, and affects soil erosion and geomorphic processes (Walter 1979, Bailey 1996). For biotic classification, vegetation has the advantage over faunal components in that plants are relatively immobile and thus easier to characterize and map (Brown et al. 1998). Natural and human disturbances have long been recognized as important factors affecting the timing and development of ecosystems (Watt 1947, Forman 1995). Because the consequences and mechanisms of disturbance are different at various hierarchical levels (Pickett et al. 1989), and thus very com-

plicated, we have chosen to emphasize only human disturbance in our classification of ecosystems.

Beyond this conceptual framework of state factor control, however, there is no single natural scale at which ecological phenomena should be studied, leading observers to impose their own perceptual bias in the study of the patterns and processes of ecological phenomena (Levin 1992, Shugart 1998). In addition, there is no nationally accepted approach to classifying ecosystems, although recent efforts have been made to develop a consensus among federal agencies (ECOMAP 1993) and among nations (Uhling and Jordan 1996, Klijn and Udo de Haes 1994). In this report, we generally have followed the scales and differentiating criteria described by Klijn and Udo de Haes (1994), which combines elements of both the Canadian (Wiken and Ironside 1977) and U.S. systems (ECOMAP 1993). This system involves numerous spatial scales for mapping ecosystems and identifies various ecosystem components as the prime criteria for differentiating successive levels of hierarchical organization.

In this report, we evaluate and present three levels of ecosystem organization, ecotypes (1:50,000 scale), ecosections (1:100,000), and ecodistricts (1:500,000). Ecotypes (also referred to as local ecosystems, ecotopes, land type phases, or vegetation types) delineate areas with homogenous topography, terrain, soil, surface form, hydrology, and vegetation. Ecosections (also landscapes, land type associations, or geomorphic sections) are homogeneous with respect to geomorphic features and have recurring patterns of water regimes, soils, and vegetation. Although several vegetation classes can be included in an ecosection, the vegetation classes usually are related because they occur as different stages in a successional sequence. Ecodistricts (or subregions, physiographic districts) are broader areas with similar geology, geomorphology, and hydrology. Ecoregions (or climatic zones), which differentiate areas based on their climatic regimes and gross physiography, have been mapped recently for Alaska by Gallant et al. (1995), although their criteria differed slightly from the above-mentioned organizational frameworks.

In Alaska, a hierarchical approach to vegetation and land cover mapping has been developed for northern Alaska by Walker and his colleagues (Walker 1983, Walker et al. 1989, Walker and Walker 1991). They also applied an integrated, geobotanical approach to mapping ecosystem components in the Prudhoe Bay region, but they

did not perform hierarchical grouping of integrated units (Walker et al. 1980). Recently, an integrated-terrain unit approach has been used for large-scale mapping of ecosystems on the Arctic Coastal Plain (Jorgenson et al. 1997) and vegetation complexes across the entire North Slope (Walker 1997). In interior Alaska, land cover mapping has been done for the Tanana Valley and adjacent Alaska Range by the Bureau of Land Management (USBLM 1997).

Spatial databases developed from an ecological land classification are essential to managing land resources and have many applications, such as use in ecological risk assessments, analysis of terrain sensitivity and wildlife habitats, wetland mitigation, planning for training exercises, facility location, identification of rare habitats, and fire management. By delineating areas with covarying climate, geomorphology (surficial geology, terrain units), surface-forms, hydrology, and biota, the resulting maps provide a spatial stratification that is particularly useful for integrated resource management based on GIS. This hierarchy of scales can help land managers and military trainers access information, identify information gaps, and improve resource management of large areas. Applications of the spatial databases produced by this project already include delineation of jurisdictional wetlands (Lichvar and Sprecher 1998), analysis of permafrost occurrence and degradation (Racine et al., in prep.), and stratification of monitoring locations for the Land Condition and Trends Analysis Program\*.

## STUDY AREA

Fort Wainwright is located near Fairbanks in central Alaska and covers approximately 368,467 ha (910,498 acres) of land (Fig. 2). Three major portions of the military base include the cantonment area with most of the facility structures, the Yukon Maneuver Area (104,503 ha), where most of the troop and aircraft exercises occur, and the Tanana Flats (263,964 ha, including a portion north of Tanana River), where occasional aircraft training takes place. In addition, several small parcels of military land in the Fairbanks area are near the cantonment area.

The continental climate of interior Alaska has extreme annual temperature variations, low

---

\* C. Bagley, Center for Ecological Management of Military Lands, Fort Collins, Colorado, pers. comm. 1998.

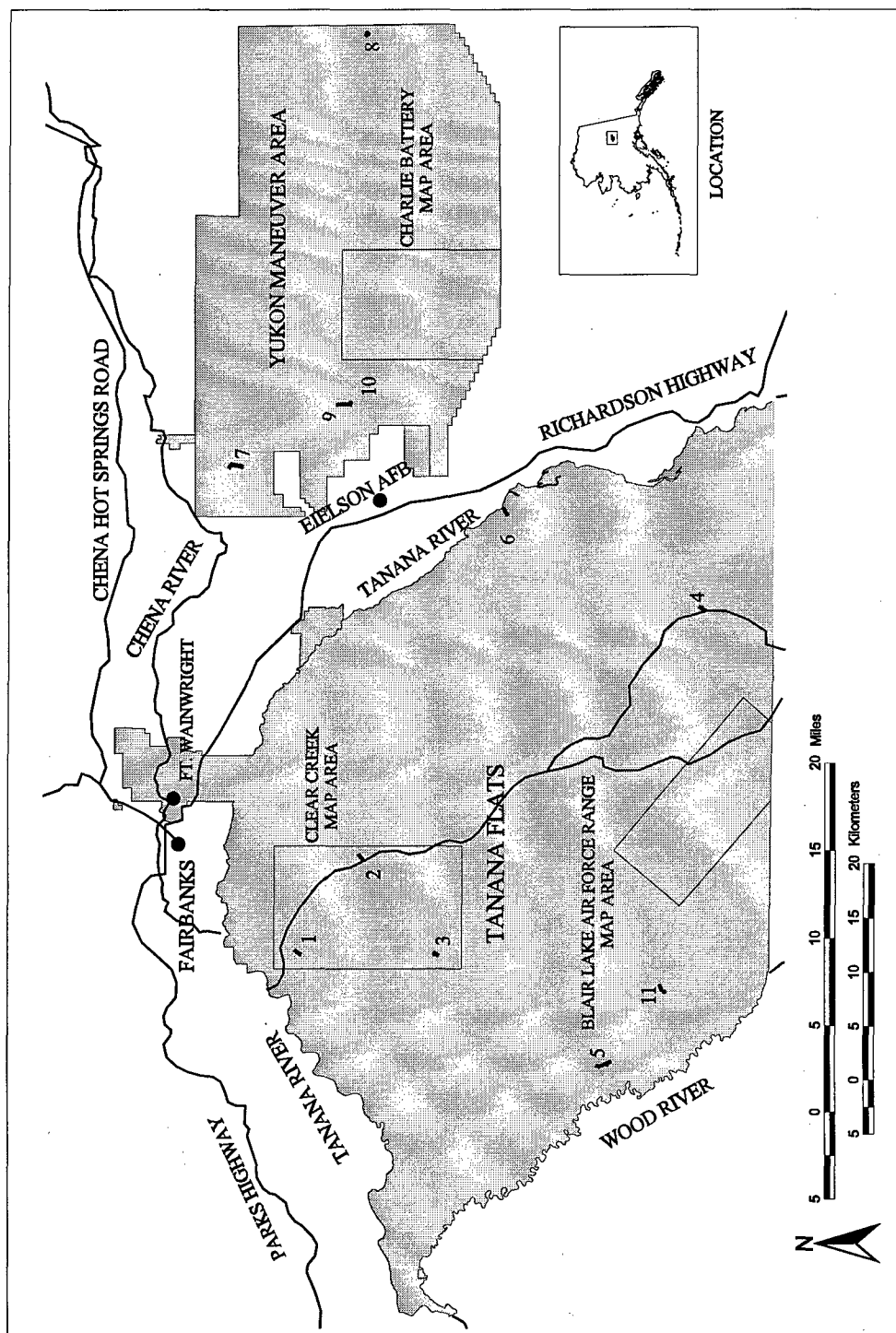


Figure 2. Location of study area and numbered survey transects for the ecological land survey of Fort Wainwright, central Alaska, 1998.



precipitation, and light surface winds. According to NOAA records, the average annual temperature is  $-3.5^{\circ}\text{C}$ , with extremes ranging from  $-51^{\circ}$  to  $38^{\circ}\text{C}$ . The average annual precipitation is 28 cm and annual snowfall averages 178 cm.

The bedrock geology of interior Alaska is dominated by Precambrian micaceous schist of the Birch Creek formation, also including metamorphic, sedimentary, and volcanic rocks of Paleozoic age (Péwé et al. 1966). Upland areas adjacent to the Tanana River usually are covered with Pleistocene loess deposits varying from a few centimeters on hilltops to over 60 m in low-lying areas. Some loess has been retransported from hills to the valley bottoms where it forms laminar to massive silt-rich deposits in organic debris (Péwé 1975). Fluvial sediments of the Tanana River occupy a large portion of the study area (Collins 1990, Mason and Beget 1991, Mann et al. 1995). Glaciofluvial sediments from both the Healy and Riley Creek glaciations are evident in the southern portion of the study area (Péwé et al. 1966, Péwé 1975, Péwé and Reger 1983).

Soils of the study area tend to be poorly developed Inceptisols, undeveloped Entisols, or Histosols (Reiger et al. 1963, 1979, Swanson and Mungoven 1998). Ochrepts (well-drained Inceptisols that have only small amounts of organic matter at the surface) occur on hills where permafrost generally is absent. Aquepts (wet Inceptisols with thin to thick layers of poorly decomposed organic matter) occur in poorly drained areas and are commonly associated with ice-rich permafrost. Aquents or Fluvents (wet mineral Entisols associated with shallow or deep water tables) occur on floodplains and seepage areas. Histol soils, such as Fibrists (deep organic soils composed mostly of undecomposed sedges or mosses), occur in depressions or wet areas that undergo long periods of soil saturation. Permafrost may or may not be present in these organic soils. Overall, permafrost tends to occur on north-facing slopes and valley bottoms and is absent on south-facing slopes, coarse-grained sediments, and areas of groundwater movement (Viereck et al. 1986, Williams 1970).

Within interior Alaska, the interrelationships among geomorphology, slope, aspect, hydrology, permafrost, and fire result in a complex pattern of vegetation types (Johnson and Vogel 1966, Nieland 1975, Van Cleve et al. 1983, 1986; Viereck et al. 1983, 1993). Taiga ecosystems are dominated by open, slowly growing spruce, interspersed with occasional dense, well-developed forest stands and

treeless bogs. On the warmest, well-drained sites, the forests consist of closed spruce-hardwood stands: white spruce (*Picea glauca*), paper birch (*Betula papyrifera*), and quaking aspen (*Populus tremuloides*). Productive balsam poplar (*Populus balsamifera*)-white spruce forests form along floodplains. On poorly drained sites, including those underlain by permafrost and on north-facing slopes, the dominant forest species is black spruce (*Picea mariana*). Bogs vary from rich sedge types to oligotrophic sphagnum bogs. Sedge-tussock meadows are prevalent. The Tanana Flats are noted particularly for the abundance of fens related to groundwater discharge from the Alaska Range (Racine and Walters 1994).

Fires occur frequently during the summer, can be widespread in occurrence, and have large ecological effects (Viereck 1973, Viereck and Schandelmeier 1980, Yarie 1981, Foote 1983). Before fire suppression, an estimated 0.6–10.0 million hectares had burned per year. Fires in interior Alaska primarily occur on tundra, bogs, and noncommercial forest lands.

## METHODS

### Field survey

Field surveys on Fort Wainwright were conducted at 240 plots during September 1994, July–September 1995, and September 1998, and included two levels of sampling effort. First, the main sampling effort was directed toward detailed descriptions of ecological characteristics along toposequences (transects) to help identify relationships among ecosystems. Second, less extensive sampling was done at sites representing areas not well documented by the transects to provide additional ground reference information for photointerpretation.

For the toposequences, 11 sites were selected in ecosubdistricts representing the range of geomorphic types throughout the study area; these types included areas of active paludification (collapse-scar fen formation), thaw settlement (thaw ponds and thermokarst terrain), fluvial processes (floodplains), glaciofluvial outwash, floodplain terraces, lowland eolian and retransported materials (lower slopes), upland slopes, and alpine tundra. Transects were located in areas that maximized the range of possible vegetation types over a short distance ( $\sim 1$  km). Sampling points for ecosystem descriptions (8–12 per transect) were located in distinct vegetation types (identifiable on aerial photographs) or vegetation types within geomor-

phic units of interest along each transect. At each sampling point, basic descriptions of geology, hydrology, near-surface soil stratigraphy, permafrost occurrence, and vegetation were made.

Topographic profiles for each transect were obtained by measuring relative elevations at topographic breaks along the length of the transects. Measurements were made with an auto-level and rod. Because the transects were located in remote locations, they were not tied into established datum, and therefore present relative, not actual, elevations. At each sampling station, notations were made describing surface form and microrelief.

Hydrologic observations included classification of the origin of water, water depth, depth to saturated soil when water was not present in soil sampling pit, pH, electrical conductivity (EC), and temperature. Water quality measurements were made with Oakton or Cole-Palmer pocket meters calibrated to standards within the range of use at regular intervals in the field. When water was not present, pH and EC were determined in a saturated paste of a mineral soil sample taken from 10- to 20-cm depth.

Soil stratigraphy was described from soil plugs dug with a shovel to approximately 50 cm using standard methods (SSDS 1993). Where possible, a soil core or tile probe was used to extend the description and to determine the depth to underlying gravel, if present. Descriptions for each profile included the texture and color of each horizon, the depth of organic matter, the depth of thaw, the type and percentage of coarse fragments, and the presence and character of mottling. All profiles were photographed. To aid analyses, textural differences within a soil profile were grouped into a single simplified texture (i.e., rocky, sandy, loamy, clayey, or organic) for a site, based on what was the dominant texture in the top 50 cm.

Vegetation structure and composition were assessed qualitatively. Percentage cover of individual species in a vegetation type was estimated visually to the nearest 5% if over 20%, and to the nearest 1% if below 20%. Dominant species were noted and a species list assembled. Total cover of growth form types (e.g., tall shrubs, low shrubs, graminoids, etc.) was evaluated independently of individual species and cross-checked for accuracy. All sites were photographed. Most species were identified in the field, and taxonomic nomenclature followed Viereck and Little (1972) for shrubs, Hultén (1968) for other vascular plants, and Vitt

et al. (1988) for mosses and lichens. Unknown species were collected for later identification. A more complete floristic inventory was conducted concurrently by the Alaska Natural Heritage Program (Racine et al. 1997).

For the ground reference sites, sampling was less intensive than the protocol used on transects. Specifically, species lists were less comprehensive and soil descriptions were restricted to shallow soil pits. Active layer depth was described where possible. Field data sheets and photos are archived at ABR, Inc.

### Classification

Ecosystem classification was approached at two levels. First, individual ecosystem components were classified and coded using standard classification systems developed for Alaska or the Arctic (Table 1). Second, these ecosystem components were integrated to classify ecosystems at three spatial scales using a variety of differentiating criteria (Table 2).

#### *Ecosystem components*

Vegetation types initially were classified to Level IV of the *Alaska Vegetation Classification* (Viereck et al. 1992) from data collected at sample sites based on structural and floristic criteria. Development of a final vegetation classification system followed an iterative process of identifying and combining vegetation types that could be recognized on aerial photography. Vegetation types that were not reliably discernible were combined with similar types. Consequently, most vegetation types used in mapping represent a range of closely related types with some variability in species composition. For example, the relatively rare Closed Quaking Aspen–Spruce Forest, which was documented from field data, was combined with the more prevalent Closed Spruce–Paper Birch–Quaking Aspen Forest in the reduced code set used for mapping. In all cases, however, an emphasis was placed on preserving differences in ecological significance and combining types only where ecological function essentially was the same.

Many areas on Fort Wainwright have a highly patchy distribution of ecosystems that is related to geomorphic or to other ecological processes associated with disturbance regimes (e.g., fires). Areas that were mosaics of related ecosystems were mapped as complexes, and the geomorphic processes causing the patchiness were used as the differentiating criteria. For example, thermal deg-

**Table 1. Coding system for the ecological land classification for Ft. Wainwright, central Alaska, 1998.**

No. code	Letter code	Geomorphic units (modified from Kreig and Reger 1982)	Code	Vegetation (after Viereck et al. 1992)
11	Bxw	Weathered Bedrock	0	Barren (<5% vegetated)
12	Bxr	Residual Soil over Weathered Bedrock	1	Water (<5% vegetated)
371	Ell	Lowland Loess	10	Partially Vegetated (>5, <30% cover)
372	Elu	Upland Loess	112	Closed White Spruce Forest
373	Elx	Upland Loess, frozen	113	Closed Black Spruce Forest
375	El/Bxw	Upland Loess/Weathered Bedrock	114	Closed Black Spruce-White Spruce Forest
376	El/Es/Fp	Upland Loess/Eolian Sand/Floodplain	115	Closed Spruce-Tamarack Forest (not mapped)
380	Es	Eolian Sand Dunes	124	Open White Spruce Forest
385	Ell+Es+Fs+Ob	Lowland Eolian Complex	125	Open Black Spruce Forest
431	Fbr	Braided Floodplain Riverbed Deposit	127	Open Black Spruce-Tamarack Forest
435	Fbca	Braided Active Floodplain Riverbed Deposit	128	Open Black Spruce-White Spruce Forest
437	Fbci	Braided Inactive Floodplain Cover Deposit	129	Open Black Spruce (South-facing)
440	Fm	Meander Floodplain, Undifferentiated	135	Black Spruce-White Spruce Woodland
441	Fmr	Meander Floodplain Riverbed Deposit	136	Mixed Conifer Woodland
445	Fmca	Meander Active floodplain Cover Deposit	143	Closed Balsam Poplar Forest
447	Fmci	Meander Inactive Floodplain Cover Deposit	144	Closed Paper Birch Forest
451	Fpar	Abandoned Floodplain Riverbed Deposit, recent	145	Closed Quaking Aspen Forest
452	Fpac	Abandoned Floodplain Cover Deposit	146	Closed Paper Birch-Quaking Aspen Forest
455	Fpac-n	Abandoned Floodplain Cover Deposit, recent	147	Closed Quaking Aspen-Balsam Poplar Forest (not mapped)
458	Fpa-g	Abandoned Floodplain-Gravel	151	Open Paper Birch Forest
461	Fpac + Off	Abandoned Floodplain Cover + Organic Fen	154	Open Paper Birch-Quaking Aspen Forest
465	Fpac + Obc	Abandoned Floodplain Cover + Organic Bog	165	Broadleaf Scrub Woodland
480	Fh	Headwater Floodplain, Small Watercourse	171	Closed Spruce-Paper Birch Forest
501	Ffbr	Alluvial Fan Abandonod Riverbed Deposit	173	Closed Spruce-Paper Birch-Quaking Aspen Forest
505	Ffcb/Ffr	Alluvial Fan Abandoned Cover Deposit	174	Closed Quaking Aspen-Spruce Forest
506	Ffct/Ffr	Dissected Alluvial Fan Cover Deposit	175	Closed Balsam Poplar-White Spruce Forest
507	Ffcb + Of	Alluvial Fan Abandoned Cover + Organic Fen	181	Open Spruce-Paper Birch Forest
508	Ffcb + Ob	Alluvial Fan Abandoned Cover + Organic Bog	182	Open Quaking Aspen-Spruce Forest
520	Fsl	Lowland Retransported Deposits	184	Open Spruce-Balsam Poplar Forest (not mapped)
523	Fsu	Upland Retransported Deposits	211	Open Black Spruce Dwarf Tree Scrub
705	GForb	Glaciofluvial Outwash Abandoned Riverbed	216	Black Spruce Dwarf Tree Woodland (not mapped)
715	GForb	Glaciofluvial Outwash Abandoned Cover	221	Closed Tall Willow Shrub
716	Gfocb + Of	Glaciofluvial Outwash + Organic Fen	222	Closed Tall Alder Shrub
717	Gfocb + Ob	Glaciofluvial Outwash + Organic Bog	224	Closed Tall Alder-Willow Shrub
718	Gfoct	Dissected Glaciofluvial Outwash Cover	231	Open Tall Willow Shrub (not mapped)
719	Gfoct + Ob	Dissected Glaciofluvial Outwash Cover + Organic Bog	232	Open Tall Alder Shrub
750	L	Lacustrine	236	Open Tall Shrub Swamp
780	H	Human-made Deposits	243	Closed Low Shrub Birch-Willow Shrub (not mapped)
835	Osp	Peat Swamp Margin	246	Closed Low Shrub Birch-Ericaceous Shrub
843	Ofd	Drainage (or Channel) Fen	249	Closed Low Scrub
844	Ofcs	Collapse Scar Fen	252	Open Low Mixed Shrub Sedge Tussock Bog
854	Ofsh/L	Shore Fent Lacustrine	253	Open Low Mesic Shrub Birch-Ericaceous Shrub
874	Obc/Fp	Collapse Scar Bog/Floodplain	255	Open Low Shrub Birch-Ericaceous Shrub Bog (not mapped)
876	Obf/Fp	Flat Bog/Floodplain	259	Open Low Scrub (Post Burn, Disturbance)
884	Obpp/Fp	Peat Plateau Bog (birch forest)/Floodplain	262	Open Low Willow-Graminoid Shrub Bog
885	Obs/L	Shore Bog (nonfloating)/Lacustrine	263	Open Low Sweetgale-Graminoid Bog
888	Obv	Veneor Bog	273	Dryas-Lichen Dwarf Shrub Tundra
			304	Midgrass Shrub
		<b>Waterbodies</b>	311	Bluejoint Meadow
906		Lower Perennial River, Nonglacial	336	Fresh Sedge Marsh
907		Lower Perennial River, Glacial	339	Subarctic Lowland Sedge-Herb Bog Meadow
911		Upper Perennial River, Nonglacial	340	Subarctic Lowland Sedge Wet Meadow
917		Spring	342	Subarctic Lowland Sedge-Bog Meadow (not mapped)
927		Deep Isolated Lake, Bedrock	343	Subarctic Lowland Sedge-Moss Bog Meadow
943	Lsir	Shallow Isolated Ponds, Riverine	366	Fresh Herb Marsh (not mapped)
944		Shallow Isolated Ponds, Thaw	368	Subarctic Lowland Herb Bog Meadow
994	Whe	Water-filled Excavation	386	Fresh Pondweed
			415	Lowland Eolian Complex
			420	Riverine Complex
			435	Slope Drainage Complex
			471	Paludification Complex, (Wet Forb-Sedge Fen)
			524	Thermokarst Complex, Open Birch-Shrub Birch-Fen
			525	Thermokarst Complex, Open Birch-Shrub Swamp-Fen
			531	Thermokarst Complex, Black Spruce-Collapse Scar Bog
			533	Thermokarst Complex, Closed Paper Birch-Collapse Scar bog
			534	Thermokarst Complex, Mixed Spruce-Paper Birch-Bog
			536	Thermokarst Complex, Open Birch-Shrub-Bog

**Table 2. Differentiation of ecosystems at various scales.**

Ecological units					Scale		Differentiating characteristics used in this study
Bailey (1997), Forman (1997)	Delcourt and Delcourt (1988)	ECOMAP (1993)	Canadian (Wiken 1981)	Klijn and Udo de Haes (1994)	Typical map scale	Typical areal extent	
Region (Forman)	Continent	Domain		Ecozone	1: 20,000,000	10 <sup>12</sup> m <sup>2</sup> 1,000,000 km <sup>2</sup>	Continents with related climate.
Ecoregion		Division		Ecoprovince	1: 10,000,000	10 <sup>11</sup> m <sup>2</sup> 100,000 km <sup>2</sup>	Climatic subzones with broad vegetation regions.
(Bailey) (macroscale)	Macro- region	Province	Ecoregion	Ecoregion	1: 5,000,000	10 <sup>10</sup> m <sup>2</sup> 10,000 km <sup>2</sup>	Climate, a geographic group of landscape mosaics (e.g., Interior Highlands).
Landscape (Forman) or Landscape	Meso- region	Section	Ecodistrict	Ecodistrict	1: 1,000,000	10 <sup>9</sup> m <sup>2</sup> 1,000 km <sup>2</sup> 100,000 ha	Major landforms or physiographic units within a climatic region (e.g., Tanana Flats, Steese-White Mountains).
Mosaic (Bailey) (mesoscale) 100 km <sup>2</sup> 10,000 ha	Microregion	Subsection	(Eco- subdistricts by ABR)		1:250,000	10 <sup>8</sup> m <sup>2</sup>	Physiographic units at larger scale based on associations of geomorphic units (e.g., grouping of weathered bedrock on crests, residual soil on upper slopes, retransported lowland deposits at toe of slopes, and headwater streams in drainages).
		Landtype Association	Ecosection	Ecosection	1:100,000	10 <sup>7</sup> m <sup>2</sup> 10 km <sup>2</sup> 100 ha	Geomorphic units with homogeneous lithology, mode of deposition, depth, texture, and water properties. Similar concepts include soil catena, toposequence, and soil association (e.g., bedrock or floodplain cover deposit).
Local Ecosystem (Forman) (Bailey) or Site (microscale)	Macrosite	Landtype	Ecosite	Ecoseries	1: 25,000– 50,000	10 <sup>4</sup> –10 <sup>6</sup> 1 km <sup>2</sup> 10–100 ha	A subdivision of a geomorphic unit that has a uniform topoclimate based on elevation, aspect, slope position, and soil drainage. Similar concepts include soil series, homogeneous abiotic site conditions climax vegetation, assemblages of vegetation types on soil series (e.g., Ester soil series on north slopes of bedrock soils).
	Mesosite	Landtype Phase	Ecoulement	Ecotype (Ecotope)	1: 5,000– 25,000	10 <sup>2</sup> –10 <sup>4</sup> 0.1–10 ha	Vegetation type or successional stage (e.g., balsam poplar on floodplain cover deposit).
	Microsite	Site		Ecoulement	1: 1,000– 5,000	10 <sup>2</sup> –10 <sup>2</sup> <0.1 ha	Uniform microsites within stand (e.g., polygon rim vs. center).

radation of permafrost, channel migration on abandoned floodplains, and water track development on retransported deposits are geomorphic processes that cause highly interspersed ecosystems that are functionally related. Areas were mapped as complexes if more than 30% of the

vegetation within a polygon (mapping region) was covered by vegetation other than the dominant type. Complexes of geomorphic units always required an associated complex of vegetation types.

Geomorphic units were classified according to

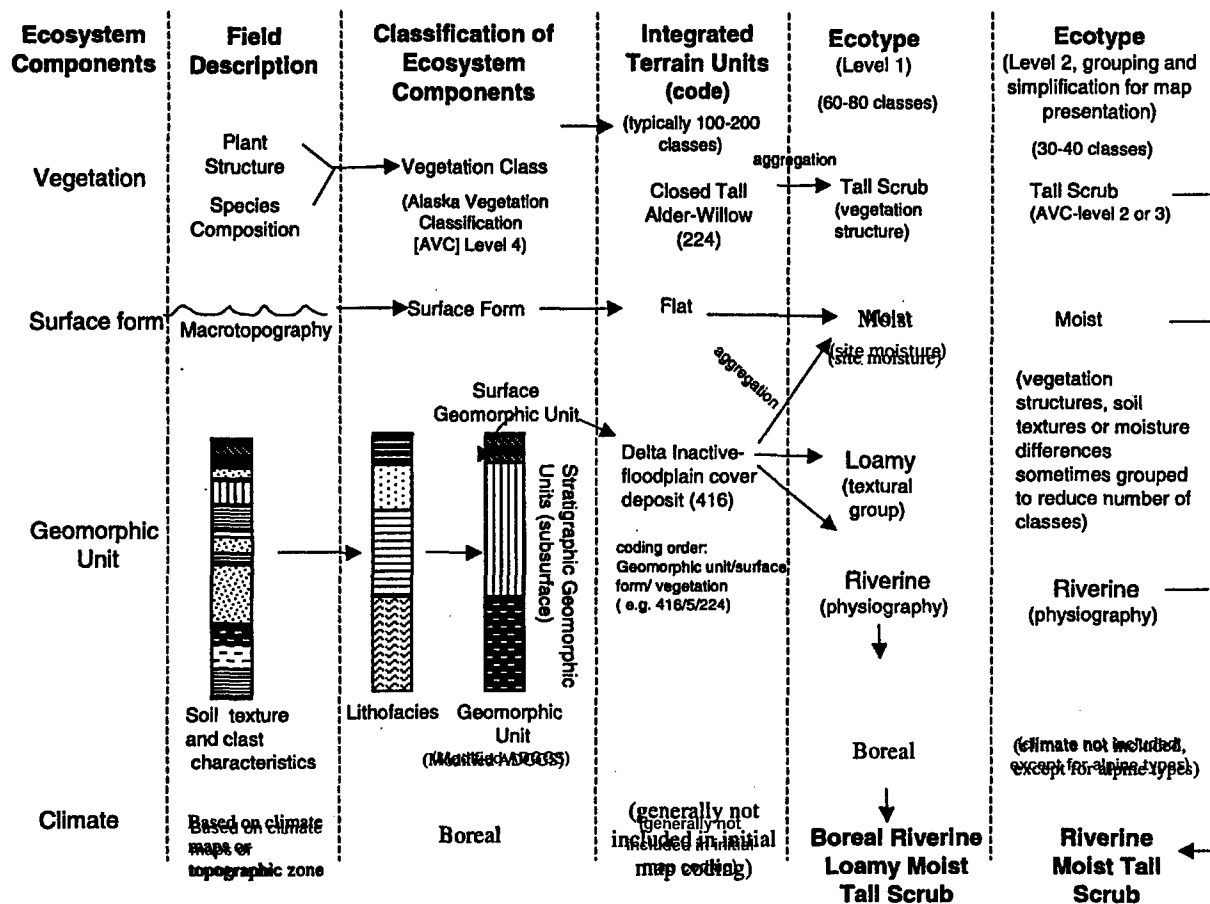


Figure 3. System for hierarchically classifying ecosystem components into integrated terrain units that explicitly denote ecosystem components and aggregating and simplifying these ITUs into ecotypes.

a system based on landform-soil characteristics originally developed by Kreig and Reger (1982) and modified for this study (App. A). Organic units were those used in wetland classification for Canada (NWWG 1988). Surface-forms were classified according to the system developed by Washburn (1973) for periglacial microtopography. Soils were classified according to *Keys to Soil Taxonomy* (Soil Survey Staff 1998). During classification of geomorphic units in the study area, we also relied on the geologic map of the Fairbanks Quadrangle (P  w   et al. 1966) and the terrain unit map of the Blair Lakes area (Kreig 1986).

#### Ecosystems

Classification of ecosystems at the ecotype level involved (1) simplification and aggregating detailed ground information on the structure and composition of ecological components to reduce complexity, (2) identification of relationships among terrain components by developing graphic pro-

files of ecosystem components along toposequences and by hierarchically aggregating plots by ecosystem components, and (3) derivation of a reduced set of ecotypes by identifying the most common relationships and central tendencies. In development of the ecotype classes, we also tried to use ecological characteristics (primarily geomorphology and vegetation structure) that could be interpreted from aerial photographs. We also developed a nomenclature for ecosystems that explicitly relates ecological characteristics in a terminology that can be easily understood.

Because ecosystems are highly complex and variable, aggregation of detailed characteristics described in the field (e.g., soil stratigraphy and vegetation composition) was necessary. For each component we used a hierarchical approach to aggregation (Fig. 3). For geomorphology we hierarchically aggregated clasts, textures, layers, and lithofacies into geomorphic units (architectural elements) using the approaches of Miall (1985)

and Brown (1997). Geomorphic units were assigned to physiographic settings based on their erosional or depositional processes (see App. A). Surface forms were simplified into a reduced set of slope elements (i.e., crest, upper slope, lower slope, toe, flat). For vegetation, we used the structural levels of the *Alaska Vegetation Classification* (Viereck et al. 1992) because they are more readily identifiable on aerial photography than are floristic composition.

Common relationships among ecosystem components were identified by visual examination of graphic profiles and by use of contingency tables. The contingency tables successively sorted plots by climate zone, physiography, texture, geomorphic unit, drainage, and vegetation type. From these tables, common associations were identified and unusual associations either were lumped with those with similar characteristics or excluded as unusual outliers. Our philosophy was that it was better to identify strong relationships that could be used for prediction and mapping than to make additional rules and classes that only increase confusion and degrade accuracy.

Ecotype names were based on the simplified ecosystem components. For example, a full name for an ecotype for an individual plot would be Boreal Upland Rocky Moist Mixed Forest based on climatic, physiographic, textural, hydrologic (moisture), and vegetative components, respectively. Because this generated a large number of specific ecotypes (89) from the 240 field plots, we aggregated many similar types into a reduced set of ecotypes (47). Sometimes textural classes were grouped (e.g., rocky and loamy) because vegetation remained similar, or similar vegetation structures (e.g., open and closed black spruce) were grouped because species composition was similar. This grouping was an arbitrary process that relied on our own perspective of what we considered to be the most important elements, our attempt to balance the need to differentiate ecological characteristics, and our effort to minimize the number of classes for management purposes. This grouping can be done in any number of ways and other users may want to group characteristics in different ways for their own individual purposes. This change can easily be done by regrouping characteristics in Appendix A and applying it to the ITU (International Telecommunication Union) codes in the database.

An important consideration in ecosystem classification is how well classes can be identified on aerial photographs. For mapping purposes, we

identified the geomorphology (e.g., meander inactive-floodplain cover deposit) and vegetation structures (e.g., broadleaf forest) associated with each ecotype based on the relationships developed from the analysis of the field data. We then were able to assign a reduced set of 44 ecotypes to 409 integrated terrain units (geomorphology/vegetation combinations) generated by the mapping (see App. A). Three of the ecotypes identified from the plot data were not mapped because they occurred in patches that were too small or could not be differentiated on the aerial photographs.

For classification of ecosystems at smaller spatial scales, geomorphic and physiographic criteria were used for differentiation (Table 2). Ecosctions were differentiated based on geomorphic patterns and processes. Because each ecosction is unique, we named the areas on the basis of a general physiographic descriptor (e.g., lowland or upland) and a prominent geographic feature (e.g., prominent creek or mountain). Classification of ecodistricts was based on general physiographic characteristics that were related to associations of geomorphic units. Naming was similar to that used for ecosctions.

#### Mapping

The mapping of ecosystems was done at three spatial scales: ecotype (1:50,000), ecosction (1:100,000), and ecodistrict and ecosubdistrict (1:250,000). The ecotypes and ecodistricts involved independent delineations, while the ecosction map was created by aggregating geomorphic units from the ecotype map.

Ecotypes were mapped by two methods. Existing Soil Conservation Service (SCS) vegetation maps (on file: Alaska Department of Natural Resources [ADNR], Division of Support Services) were available for USGS quadrangles Fairbanks B1, B2 (eastern half only), C1, C2, C3, C4, D1, and D2, and Big Delta B6, C5, C6, D5, and D6 (SCS/ADNR 1990). SCS polygons were transferred to acetate and overlain on 1995 1:24,000 true-color aerial photographs for the Tanana Flats and 1:30,000 enlargements of 1979 and 1986 1:63,360 color-infrared photographs for the Yukon Maneuver Area. Polygons were recoded with an integrated-terrain-unit system that included both a geomorphology and vegetation code, and boundaries redrawn where necessary. Minimum mapping units for polygons were approximately 1.5 ha for complexes and 0.5 ha for other polygons.

For areas lacking SCS mapping, and for three areas where we wanted to do more detailed map-

ping (lower Clear Creek, Blair Lakes Training Facilities, and Charlie Battery), polygon boundaries were delineated on acetate overlaying the photographs using a mirror stereoscope. The boundaries were digitized and geo-rectified using control points obtained from distinct geographic features recognizable on both the photographs and Fort Wainwright Military Installation Maps (1:50,000, Defense Mapping Agency Hydrographic/Topographic Center, 1986). Reservation boundaries and roads were obtained from the U.S. Army Corps of Engineers. The positions of road corridors were updated using SPOT satellite imagery. Maps were generated using Atlas GIS and Arc View software (ESRI, Redlands, California, 1996).

The mapping of vegetation at 1:50,000 scale and use of the pre-existing SCS vegetation maps for ecosystem mapping, which were based on integrated geomorphology-vegetation classes, required some compromises. First, the small scale required a compromise in our ecosystem classification approach. A true ecotype map should delineate individual vegetation types, while our polygons, which relied heavily on the SCS maps, resulted in numerous large polygons that included several vegetation types. In our revisions of the SCS maps, we emphasized reviewing the vegetation classification for each polygon and inserting breaks where polygons crossed geomorphic boundaries. Because of the large effort that would have been required, we decided to accept these inconsistencies related to scale and inclusions and use the pre-existing maps that covered much of the area.

Ecosection maps were produced by aggregating ecotypes based on geomorphic units. Ecodistricts were delineated by overlaying acetate on a 1:175,000 false-color composite of 1991 Landsat TM (thematic mapper) imagery. The satellite image was georeferenced using USGS (U.S. Geological Survey) topographic maps.

### **Classification and mapping**

The development of an ecological land classification at multiple spatial scales involved three phases: (1) classification of ecosystem components (topography, geomorphology, hydrology, soils, and vegetation) from field data using standard classification systems, (2) derivation of a reduced set of ecotypes (local ecosystems) by identifying associations among ecosystem components through graphical portrayal of spatial relationships along toposequences and hierarchical

grouping of ecosystem components, and (3) classification and mapping of smaller-scale ecosystems (ecosections and ecodistricts). Results of the classification and mapping of the various ecosystem components (geomorphology and vegetation) and ecosystems at the various scales are described below by providing a tabular description of each map unit, a map, and a tabular summary of spatial extent.

### *Ecosystem components*

**Geomorphology.** Field surveys identified 52 geomorphic units within the study area and included 43 terrestrial units and 9 water body classes (Table 3). During mapping, 47 geomorphic units were used, including 8 complex units (Table 4, Fig. 4 and 5). Five units were not mapped, however, because they were either too small in extent or could not be differentiated on the aerial photography. Classification and mapping was based on the geomorphic unit at the surface, although stratigraphic units that commonly are associated with the surface geomorphic unit are included in the descriptions.

Within the Yukon Maneuver Area (YMA), the dominant geomorphic units include Residual Soil, Upland Loess, Lowland Retransported Deposit, Lowland Loess, Lowland Eolian Complex, and Headwater Floodplain. These geomorphic units reveal the dominance of hill slope and eolian processes. Within the Tanana Flats, the dominant geomorphic units include Meander Inactive Floodplain Cover Deposit, Abandoned Floodplain Cover Deposit, Organic Fen, Organic Bog, Alluvial Fan Abandoned Cover Deposit, Glaciofluvial Outwash Abandoned Cover Deposit, and Collapse Scar Fen. These deposits reveal the Tanana Flats are dominated by fluvial processes and organic deposits associated with thermokarst. Much of the area was mapped as complex units because of the high interspersed of organic deposits associated with thermokarst.

The geomorphic units are ecologically important because they represent areas with differing erosional and depositional environments and, therefore, are affected differentially by natural occurring disturbances. For example, Meander Active Floodplain Cover Deposits are flooded frequently, and the frequent sediment deposition prevents development of a moss layer and contributes nutrients that presumably contribute to the vigorous growth of shrubs and saplings on well-drained soils. Abandoned Floodplain Cover Deposits, on the other hand, are rarely flooded

**Table 3. Description of geomorphic units within Ft. Wainwright, central Alaska, 1998.**

<i>Geomorphic unit</i>	<i>Description</i>
Weathered Bedrock (Bxw)	Highly fractured or poorly consolidated bedrock that can have soil-like properties, but has more evidence of primary structures than residual soil. Ground surface has abundance of exposed rock blocks. In the study area, this unit was limited to alpine areas where soil formation is minimal.
Residual Soil over Weathered Bedrock (Bxr)	Completely weathered material formed from underlying bedrock conditions that has soil-like properties and little or none of the original primary structures remaining. Typically there is an increase in particle size at the base of the soil as it grades into weathered bedrock below. Thin (<30-cm) deposits of colluvial, eolian, or slope wash deposits can be included in this class. Permafrost generally is absent on south-facing slopes, whereas north-facing slopes are frozen. Most residual soils in the study area are formed from Birch Creek Schist, a metamorphic rock dominated by micaceous minerals.
Lowland Loess (Ell)	Windblown silt deposited on poorly drained lowland locations in complex depositional environments near large river floodplains. The deposit may contain a mixture of eolian sand, retransported, and organic deposits in close association with the deposits of massive silt. Small hills generally have a thin cover of loess over eolian sand, whereas swales often contain retransported deposits with higher clay contents or thick organic deposits. In the flat and lowland portions of this unit, the soil is normally frozen with a high ice content. Small collapse-scar bogs are common. This unit is limited to the flats between the Tanana River floodplain and the Chena-Salcha Highlands.
Upland Loess/Weathered Bedrock (El/Bxw)	Windblown silt deposited on well-drained upland slopes. Gully pattern associated with these easily eroded deposits is usually evident on airphotos. Massive silt deposit lacks horizontal stratification and coarse fragments associated with residual soil or retransported deposit. Deposit must be at least 40 cm thick. Permafrost is absent. This unit occurs on the Chena-Salcha Highlands near the Tanana River at elevations below 300 m.
Upland Loess/Eolian Sand/Floodplain (El/Es/Fp)	Windblown silt capping eolian sand dunes deposited over floodplain deposits. Typical profile consists of 0.1 m of organic material, 0.5–1 m of massive silt, 2 m or more of fine to medium sand, over fluvial gravel. Permafrost generally is absent. This unit occurs at scattered locations in the Crooked Creek Flats, Wood River Lower Fan, Dry Creek Fan, and French-Moose Creek Lowlands.
Lowland Eolian Complex (Ell+Es+Fs+Ob)	Contains a distinct assemblage of lowland loess, eolian sand, retransported, and organic bog deposits that occur in a mosaic where individual deposits are too small to map separately. The topography has small knobs associated with stabilized dunes, swales where more clay-rich retransported deposits have accumulated, and thermokarst collapse scars where organic bog material has accumulated. See descriptions of individual deposits for more detail.
Braided Floodplain Riverbed Deposit (Fbr)	Floodplain materials deposited in a river where flow is separated by bars within channels and the stream possesses a higher sediment load than the energy level the stream can support. Sediments generally are composed of coarse-grained detritus. This unit is found along the Tanana River near Eielson AFB.
Braided Active Floodplain Cover Deposit (Fbca)	Relatively fine-grained cover deposits associated with a braided floodplain that are subject to frequent (every 1–2 years) flooding and deposition. Due to frequent deposition, the surface usually is partially vegetated or has riverine shrubs, but organic material can not accumulate at the surface. A typical profile has stratified silty and sandy material deposited during frequent overbank flooding events and lack interbedded organic horizons typical of inactive cover deposits. The cover deposits typically are 0.5–1 m thick over gravelly riverbed deposits. This unit forms thin margins adjacent to riverbed deposits along the Tanana River near Eielson AFB.
Braided Inactive Floodplain Cover Deposit (Fbci)	Relatively fine-grained cover or vertical accretion deposits formed from infrequent (every 3–5 years or less frequent) overbank flooding events. Due to the infrequent deposition organic matter accumulates at the surface and deposits have distinct interbedding of organic and mineral layers. A typical profile has 0.05–0.2 m of organic material, 0.5–1 m of interbedded organic horizons and silty or sandy silt layers, 1–2 m of interbedded silts and sands representing old active cover deposits, over gravelly riverbed deposits. Permafrost generally is absent. This unit forms extensive floodplain margins adjacent to the Tanana River near Eielson AFB.
Meander Floodplain Riverbed Deposit (Fmr)	Includes both meandering and anastomosing channel patterns characterized by channels that wind freely in regular to irregular, well-developed, S-shaped curves (meandering) or have sinuous unbranched channels (anastomosing). River bed material can range from gravel to gravelly sand.
Meander Active Floodplain Cover Deposit (Fmca)	Similar in material type and stratigraphy as braided active floodplain cover deposits but it occurs on meander flood plains.
Meander Inactive Floodplain Cover Deposit (Fmci)	Similar in material type and stratigraphy as braided inactive floodplain cover deposits but it occurs on meander flood plains.



Table 3 (cont'd).

<i>Geomorphic unit</i>	<i>Description</i>
Abandoned Floodplain Cover Deposit (Fpac/Fpr)	Vertical accretion deposits of a floodplain that no longer is associated with the present fluvial regime or where flooding is sufficiently infrequent that fluvial sediments form a negligible component of surface material. The abandoned floodplain is an older, commonly frozen portion of a floodplain, particularly in permafrost areas, which can include a mixture of fluvial, eolian, and organic materials. A typical profile includes 0.3–1.5 m of organic material with few thin mineral layers, and 1–2 m of fine-grained cover deposits over gravelly riverbed material. Organic deposits (>40 cm) are difficult to distinguish from this unit, so this unit often includes thick accumulations of peat at the surface.
Abandoned Floodplain Meander Riverbed (Fparm)	Generally coarse-grained fluvial materials deposited within channels of recently abandoned channels of meandering rivers. This unit is found in the riverbeds of formerly meandering streams in the Willow Creek and Crooked Creek Lowlands that have recently been abandoned as groundwater flow has increased and surface flow has decreased. In many places, the old channels have filled with fine-grained deposits, which then are classified as abandoned floodplain cover deposits.
Abandoned Floodplain Braided Floodplain Riverbed Deposit gravel (Fparb)	Generally coarse-grained riverbed materials in recently abandoned floodplains that lack significant accumulations of fine-grained cover deposits. The braided pattern of the old channels still are evident. The old channels generally have an organic-rich, fine-grained cover deposits, while the old riverbars have gravel near the surface. Permafrost generally is absent. This unit occurs in the Bear Creek and Eielson Lowlands.
Abandoned Floodplain Cover + Organic Fen (Fpac + Off)	This geomorphic complex includes ice-rich abandoned floodplain cover deposits and organic fen deposits that have formed in areas of thermal degradation of the cover deposits. See descriptions of the separate deposits.
Abandoned Floodplain Cover + Organic Bog (Fpac + Obc)	This geomorphic complex includes ice-rich abandoned floodplain cover deposits and organic bog deposits that have formed in areas of thermal degradation of the cover deposits. See descriptions of the separate deposits.
Headwater Floodplain (Fh)	Small, shallow deposits formed in the headwater of small creeks. Deposits may range from boulders in narrow, incised channels to fine-grained material in broader floodplains. This unit is found in the Yukon-Tanana Uplands district.
Alluvial Fan Abandoned Riverbed Deposit (Ffrrb)	Alluvial fans are gently sloping cone-shaped deposits of coarse-grained alluvium formed where a stream course extends onto a relatively level plain. Abandoned riverbed deposits on fans contain coarse-grained material and frequently include cobbles and boulders. Significant fine-grained cover deposits are lacking. This unit is found in the Dry Creek Fan area.
Alluvial Fan Abandoned Cover Deposit (Ffcb/Ffr)	Fine-grained cover deposits associated with overbank flooding on alluvial fans. The material is ice-rich and thermokarst features are prevalent. This unit is found in the Dry Creek Fan area.
Dissected Alluvial Fan Cover Deposit (Ffct/Ffr)	Similar to above except that the surface is dissected, reflecting older deposits. This unit is found in the Dry Creek Fan area.
Lowland Retransported Deposits (Fsl)	Fine-grained, organic-rich materials moved downslope by slopewash, solifluction, and in some cases, piping and, thus, are influenced by both fluvial and gravity processes. Loess also may be incorporated in these deposits. On airphotos, the surface has a feather pattern indicative of small-scale fluvial processes and typically occur on the lower portion of slopes. The material generally is frozen and ice rich. This unit is associated with upland areas.
Upland Retransported Deposits (Fsu)	Generally silty to sandy material with occasion gravel-sized fragments that occur in horizontally stratified deposits indicative of fluvial origin. This unit generally occurs at the upper portion of lower slopes and forms a transition zone between residual soils and lowland retransported deposits.
Undifferentiated Fluvial/Glaciofluvial Deposit (FG)	Granular deposits in areas of nonglacial floodplains, granular alluvial fans, and glacial outwash plains that have an unspecified origin. In proglacial environments, glaciofluvial deposits grade into nonglacial fluvial deposits, and this class is utilized in these transitional areas. In the study area, FG is used when designating subsurface fluvial layers.

**Table 3 (cont'd). Description of geomorphic units within Ft. Wainwright, central Alaska, 1998.**

<i>Geomorphic unit</i>	<i>Description</i>
Glaciofluvial Outwash Abandoned Riverbed (GForb)	Deposits formed by meltwater streams beyond the terminal glacial margin. They are similar in character to alluvial fan deposits described above and lack significant accumulations of fine-grained cover deposits. These deposits are found where Wood River exits the mountains and were formed during the Riley Creek Glaciation.
Glaciofluvial Outwash Abandoned Cover (GFocb)	Fine-grained material deposited by overbank flooding events on glaciofluvial outwash fans. Sediments range from sandy silts to clay material deposited in slackwater environments. Permafrost is present in most areas except where active thermal degradation is occurring. The outwash fan is characterized by numerous groundwater seeps and near linear headwater streams that form a dense fluvial pattern on the surface. This unit is found on the lower portion of the outwash fan associated with the Wood River.
Dissected Glacio- fluvial Outwash Cover (GFact)	Similar to above except the surface is dissected and frequently forms terraces above the surrounding deposits. Thermokarst features are prevalent. The deposits probably were formed during the Healy glaciation.
Lacustrine (L)	Silt and clay materials deposited in both glacial and nonglacial lakes. Lake sediments generally are well stratified into very thin laminations, but may also include coarse-grained sediments associated with shorelines and fluvial sediments in deltas and fans.
Collapse Scar Fen (usually Off/Fpac/Fpr)	A thick (>40 cm) organic deposit associated with minerotrophic groundwater movement. The mat of live, fibrous roots and loosely consolidated poorly decomposed organic material forms a floating mat, underlain by water or loose fluid peat. The fen surface is near (<10 cm) the water level. The deposits are associated with the degradation of ice-rich permafrost.
Drainage Fen (usually Ofd/ Fpac)	Minerotrophic peatland forms (also called channel fens) that have a generally flat and featureless surface that slopes gently in the direction of drainage. The fens are confined to narrow, well-defined drainages in gently rolling topography. The underlying peat deposit is poorly to moderately well decomposed and ranges in thickness from 40 cm to 2 m.
Shore Fen/ Lacustrine (Ofs/L)	A fen with an anchored surface mat that forms the shore of a pond or lake. The rooting zone is affected by lake water.
Veneer Bog (usually Obf/Fsl or Bxr)	Bogs have thick (>40 cm) accumulations of organic matter and the water table is usually at or near the surface. The bog surface is virtually unaffected by the nutrient-rich groundwaters from the surrounding mineral soils and, thus, is acidic and low in nutrients. The dominant materials are weakly to moderately decomposed Sphagnum and woody peat, underlain at times by sedge peat. Veneer bogs are extensive peat deposits that occur more or less uniformly over gently sloping hills and valleys.
Collapse Scar Bog (usually Obc/Fpac)	A circular or oval-shaped wet depression formed from thermal degradation of ice-rich permafrost. The depression is poor in nutrients because it is not connected to minerotrophic fens. This unit is associated with abandoned floodplain cover deposits and frequently is mapped as part of a geomorphic complex because of their small size and abundance.
Flat Bog (usually Obf/Fpac)	A bog having a flat, featureless surface and occurs in broad poorly drained depressions or abandoned floodplains. This unit is difficult to distinguish without detailed soil information and is usually included in the Abandoned Floodplain Cover Deposit.
Peat Plateau Bog (usually Obpp/Fpac)	A bog with thick accumulations of peat over fine-grained mineral soil, rising abruptly about 1 m from the surrounding unfrozen fen. The peat was originally deposited in a nonpermafrost environment and is often associated with collapse scar bogs and fens. This unit is difficult to distinguish in the study area without detailed soil information and usually is grouped with Abandoned Floodplain Cover Deposits. This unit is tentatively used for a problematic situation where birch forests are growing on degrading permafrost situations. A thick (0.5–0.8 m) surface of peat has accumulated at the surface.
Shore Bog (usually Obs/L)	A nonfloating bog forming at the shore of a pond or lake. The bog surface is elevated at least 0.5 m above the level of the lake. The bog often encroaches over the lake.
Human Made Deposits (H)	Gravel fill in roads and pads, also cut and fill material associated with roads.

**Table 4. Areal extent of geomorphic units within the Yukon Maneuver Area (YMA) and Tanana Flats (Flats) portions of Ft. Wainwright, central Alaska, 1998.**

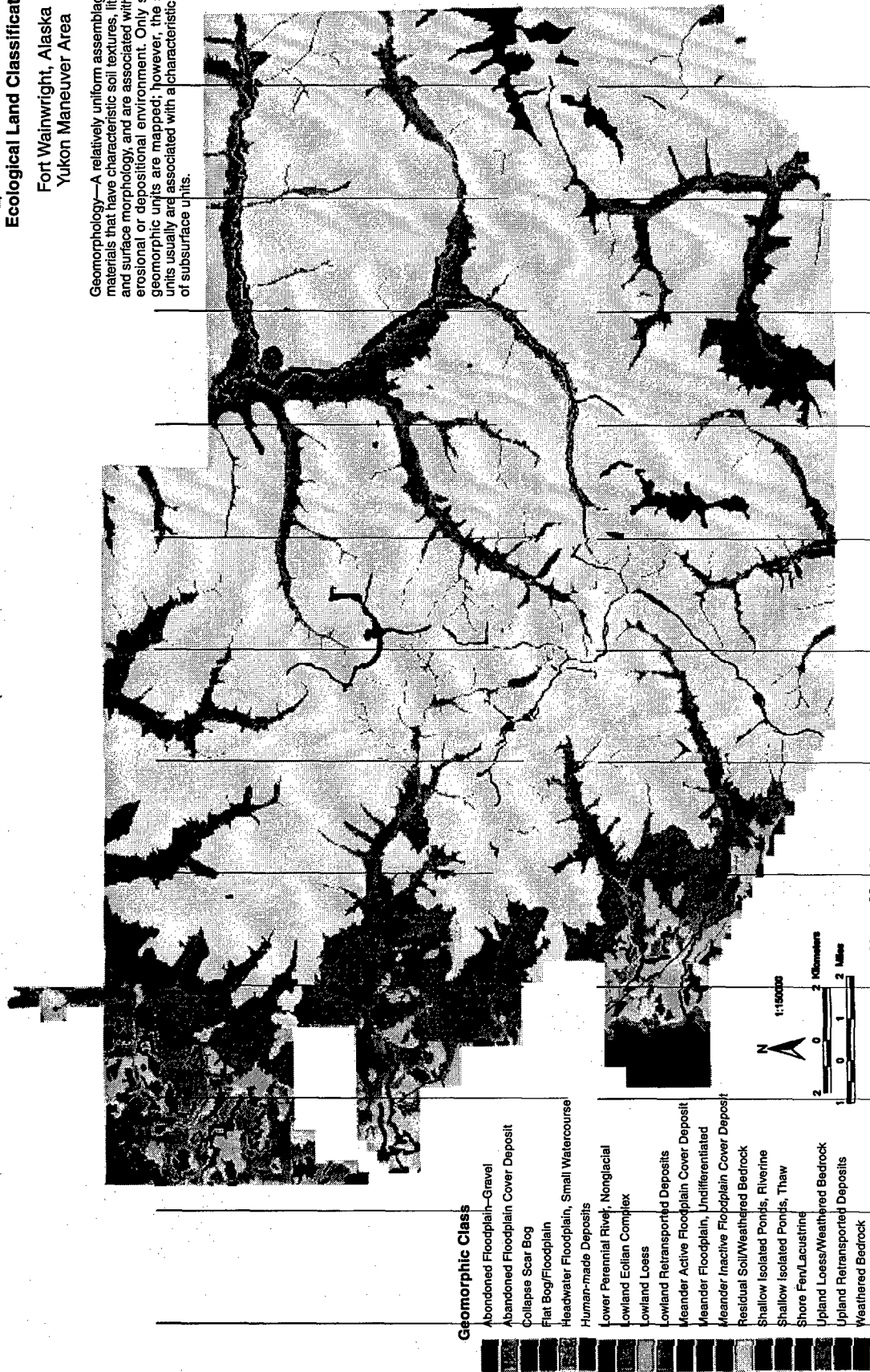
<i>Geomorphic class</i>	<i>Flats</i>		<i>YMA</i>		<i>Total</i>	
	<i>area (ha)</i>	<i>%</i>	<i>area (ha)</i>	<i>%</i>	<i>area (ha)</i>	<i>%</i>
Weathered Bedrock			1208	1.2	1208	0.3
Residual Soil over Weathered Bedrock	4046	1.5	71,418	68.3	75,464	20.5
Lowland Loess			2956	2.8	2956	0.8
Upland Loess/Weathered Bedrock			2771	2.7	2771	0.8
Upland Loess/Eolian Sand/Floodplain	180	0.1			180	0.0
Lowland Eolian Complex			4104	3.9	4104	1.1
Braided Floodplain Riverbed Deposit	237	0.1			237	0.1
Braided Active Floodplain Riverbed Deposit	791	0.3			791	0.2
Braided Inactive Floodplain Cover Deposit	4652	1.8			4652	1.3
Meander Floodplain, Undifferentiated			928	0.9	928	0.3
Meander Floodplain Riverbed Deposit	97	0.0			97	0.0
Meander Active Floodplain Cover Deposit	227	0.1	3	0.0	229	0.1
Meander Inactive Floodplain Cover Deposit	15,169	5.7	312	0.3	15,480	4.2
Abandoned Floodplain Riverbed Deposit, Recent	1397	0.5			1397	0.4
Abandoned Floodplain Cover Deposit	63,468	24.0	337	0.3	63,804	17.3
Abandoned Floodplain—gravel	12,219	4.6	807	0.8	13,025	3.5
Abandoned Floodplain Cover + Organic Fen	26,566	10.1			26,566	7.2
Abandoned Floodplain Cover + Organic Bog	35,495	13.4			35,495	9.6
Headwater Floodplain, Small Watercourse	3056	1.2	3198	3.1	6254	1.7
Alluvial Fan Abandoned Riverbed Deposit	1262	0.5			1262	0.3
Alluvial Fan Abandoned Cover Deposit	21,442	8.1			21,442	5.8
Dissected Alluvial Fan Cover Deposit	3845	1.5			3845	1.0
Alluvial Fan Abandoned Cover + Organic Fen	1758	0.7			1758	0.5
Alluvial Fan Abandoned Cover + Organic Bog	2355	0.9			2355	0.6
Lowland Retransported Deposits	1908	0.7	14,486	13.9	16,393	4.4
Upland Retransported Deposits	1517	0.6	449	0.4	1966	0.5
Glaciofluvial Outwash Abandoned Riverbed	1953	0.7			1953	0.5
Glaciofluvial Outwash Abandoned Cover	31,584	12.0			31,584	8.6
Glaciofluvial Outwash + Organic Fen	1785	0.7			1785	0.5
Glaciofluvial Outwash + Organic Bog	978	0.4			978	0.3
Dissected Glaciofluvial Outwash Cover	6640	2.5			6640	1.8
Dissected Glaciofluvial Outwash Cover + Organic Bog	180	0.1			180	0.0
Human-made Deposits	42	0.0	394	0.4	435	0.1
Drainage (or Channel) Fen	2731	1.0			2731	0.7
Collapse Scar Fen	10,290	3.9			10,290	2.8
Shore Fen/Lacustrine	909	0.3	106	0.1	1015	0.3
Collapse Scar Bog/Floodplain	224	0.1	19	0.0	243	0.1
Flat Bog/Floodplain			890	0.9	890	0.2
Veneer Bog	2159	0.8			2159	0.6
Lower Perennial River, Nonglacial	14	0.0	39	0.0	53	0.0
Lower Perennial River, Glacial	2138	0.8			2138	0.6
Spring	27	0.0			27	0.0
Deep Isolated Lake, Bedrock	429	0.2			429	0.1
Shallow Isolated Ponds, Riverine	9	0.0	5	0.0	14	0.0
Shallow Isolated Ponds, Thaw	185	0.1	75	0.1	260	0.1
Water-filled Excavation	2	0.0			2	0.0
<i>Sum</i>	263,964	100.0	104,503	100.0	368,467	100.0

## Geomorphology

### Ecological Land Classification

Fort Wainwright, Alaska  
Yukon Maneuver Area

Geomorphology—A relatively uniform assemblage of earth materials that have characteristic soil textures, lithologies, and surface morphology, and are associated with a particular erosional or depositional environment. Only surface geomorphic units are mapped; however, the surface units usually are associated with a characteristic sequence of subsurface units.



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 4. Map of geomorphic classes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.



and thus lack sediment input. Vegetation tends to be dominated by slowly growing, evergreen species that tolerate stressful, low-nutrient conditions. In addition, the fine-grained deposits can be extremely ice-rich and are highly susceptible to thermokarst. Rocky residual soil in the upland area of the YMA also lacks active sedimentation, is thaw stable, and tends to be dominated by black spruce.

The water body classification differentiates numerous characteristics that are ecologically important to invertebrates, fish, and wildlife. In general, rivers are different from lakes, glacial rivers are rich in sediment whereas nonglacial rivers have higher humic and tannic compounds, shallow water tends to melt earlier and become warmer than deep water, connected lakes allow better fish passage than isolated lakes, and riverine ponds are prone to flooding and sedimentation. Only a few of these characteristics were differentiated in the final ecotypes (see *Ecotypes* section) to reduce the number of classes. For habitat studies, these waterbody types are preserved in the ITU code in the mapping and can be used for specific analyses.

**Vegetation.** Field surveys identified 49 vegetation types within the study area (Table 5). During mapping, 35 vegetation types, 3 nonvegetated classes (water, barren, partially vegetated), and 10 complex units were recognized (Table 6, Fig. 6 and 7). The complex classes were associated with geomorphic processes (particularly thermokarst) that created highly patchy vegetation distributions. Eleven vegetation types were not mapped because they either were too small in extent or could not be differentiated on the aerial photography (denoted by \* on Table 1).

Within the YMA, the dominant vegetation types included Open Black Spruce Forest, Closed Paper Birch–Quaking Aspen Forest, Closed Spruce–Paper Birch Forest, Closed Spruce–Paper Birch–Quaking Aspen Forest, and Open Spruce–Paper Birch Forest. Nonforest types were limited in extent. Within the Tanana Flats, the dominant vegetation types included Closed Black Spruce Forest, Open Black Spruce Forest, Open Black Spruce–Tamarack Forest, Closed Spruce–Paper Birch Forest, Closed Low Shrub Birch–Ericaceous Shrub, and Closed Low Scrub. In addition, various thermokarst complexes were common. Shrub and herbaceous types were much more abundant on the Tanana Flats. Differences in vegetation mostly were due to differences in upland (YMA) and lowland (Tanana Flats) topography.

The use of the Alaska Vegetation Classification (AVC) for classification generated a large number of classes due to changes in the canopy coverage (open, closed, woodland) of trees and shrubs. In many cases, such as for the black spruce types, the understory vegetation was similar among the classes. Similarly, small changes in tree composition led to generation of a large number of deciduous and mixed forest classes. We also created five new classes that were not in the AVC due to canopy cover problems, including Closed Spruce–Tamarack Forest (no closed canopy class existed), Mixed Conifer Woodland (no woodland class with Tamarack), Open Paper Birch–Quaking Aspen Forest (no open canopy class existed), Closed Low Shrub Birch–Ericaceous Shrub (no closed class existed), and Lowland Sedge–Herb Bog Meadow (needed to recognize herb-rich meadows in infilling ponds).

#### *Association among ecosystem components*

**Toposequences.** The principal foundation for ecosystem classification was the survey of ecosystem components (e.g., topography, geomorphology, soils, hydrology, permafrost, and vegetation) along 11 toposequences and at 131 ground reference sites (App. B and C). Cross-sectional profiles were constructed to illustrate the relationship among geomorphology, hydrology, vegetation, and permafrost along the 11 toposequences (Fig. 8–22). The toposequences display two-dimensional views of the structure of the lithofacies that were used as the basis for classifying and mapping geomorphic units. Examples of toposequences from the three ecodistricts (Tanana Flats, Tanana Floodplain, and White Mountains, see *Ecodistricts* section) are presented below to illustrate some of the main ecological relationships within Fort Wainwright.

Within the Tanana Flats Ecodistrict, the geomorphology is dominated by deposits of the thick (2- to 4-m) silty and ice-rich abandoned-floodplain cover over gravelly riverbed deposits with numerous organic deposits in collapse-scar bogs and fens. These have resulted from thaw degradation of permafrost (Fig. 9–15 and 22). This permafrost degradation has created some of the more unique ecosystems found within the study area. In areas where thaw degradation is rapid, birch forests are common on the slightly elevated (1- to 2-m) plateaus adjacent to the fens as a result of lowering of the water table and aeration of soils (Fig. 9–11). The soils associated with the birch forest have thick (0.5- to 0.8-m) peat layers resulting

**Table 5. Description of vegetation types (Level IV, Alaska Vegetation Classification) found on Ft. Wainwright, central Alaska, 1998. For more complete descriptions see Viereck et al. (1992).**

Class	Description
Closed White Spruce Forest	Closed (>60% crown cover) stands of <i>Picea glauca</i> , deciduous tree cover is low. In upland areas, the understory includes <i>Salix</i> spp., <i>Vaccinium vitis-idaea</i> , <i>Mertensia paniculata</i> , <i>Equisetum sylvaticum</i> , and feather mosses; whereas <i>Rosa acicularis</i> , <i>Cornus canadensis</i> are more common in riverine areas.
Closed Black Spruce Forest	Dense, mature stands (>60% crown cover) of <i>Picea mariana</i> . In uplands, the understory has <i>Alnus crispa</i> , ericaceous shrubs, grasses ( <i>Arctagrostis latifolia</i> ), and feather mosses. In lowlands, <i>Sphagnum</i> is more common.
Closed Black Spruce–White Spruce Forest	Mixed stands of <i>Picea mariana</i> and <i>P. glauca</i> totaling >60% canopy cover. The understory consists of <i>Alnus crispa</i> , <i>Ledum groenlandicum</i> , <i>Vaccinium vitis-idaea</i> , and feather mosses.
Closed Spruce–Tamarack Forest	Closed (>60%) stands of <i>Picea mariana</i> and <i>Larix laricina</i> . <i>Ledum groenlandicum</i> , <i>Vaccinium vitis-idaea</i> and other ericaceous shrubs form the understory, along with lichens and mosses.
Open White Spruce Forest	Open (25–60% cover) stands of <i>Picea glauca</i> , with an understory of <i>Salix bebbiana</i> , <i>Cornus canadensis</i> , <i>Equisetum arvense</i> , <i>Viburnum edule</i> , <i>Goodyera repens</i> , <i>Rosa acicularis</i> , <i>Linnaea borealis</i> , <i>Hylocomium splendens</i> , <i>Rhytidiadelphus loreus</i> , and other feather mosses.
Open Black Spruce Forest (other than south-facing)	Open (25–60%) stands of <i>Picea mariana</i> with occasional <i>Larix laricina</i> on north-facing slopes and lowlands. The understory has low shrubs ( <i>Rosa acicularis</i> , <i>Salix</i> spp., <i>Ledum groenlandicum</i> , <i>Empetrum nigrum</i> , <i>Vaccinium vitis-idaea</i> ), <i>Sphagnum</i> spp., and feather mosses.
Open Black Spruce Forest (south-facing slopes)	<i>Picea mariana</i> dominates the open stands (25–60% cover). On south-facing slopes scattered tall shrubs ( <i>Alnus crispa</i> ), low and dwarf shrubs ( <i>Ledum groenlandicum</i> , <i>Empetrum nigrum</i> , <i>Vaccinium vitis-idaea</i> ), grasses ( <i>Calamagrostis</i> spp. and <i>Arctagrostis latifolia</i> ) and feather mosses are common.
Open Black Spruce–White Spruce Forest	Mixed stands of black ( <i>Picea mariana</i> ) and white ( <i>P. glauca</i> ) spruce with <60% canopy cover. The understory has <i>Alnus crispa</i> , <i>Ledum groenlandicum</i> , <i>Vaccinium vitis-idaea</i> , and feather mosses.
Open Spruce–Tamarack Forest	<i>Larix laricina</i> and <i>Picea mariana</i> (occasionally <i>P. glauca</i> ) form an open (25–60%) canopy. The understory has ericaceous shrubs, <i>Oxycoccus microcarpus</i> , <i>Rubus chamaemorus</i> and <i>Sphagnum</i> spp.
Black Spruce–White Spruce Woodland	Occasional <i>Picea glauca</i> and <i>P. mariana</i> (10–25% cover) represent the tree canopy in these stands which are dominated by low shrubs. Shrubs include <i>Ledum groenlandicum</i> , <i>Betula nana</i> , <i>Vaccinium uliginosum</i> , <i>Vaccinium vitis-idaea</i> , and feather mosses.
Mixed Conifer Woodland	Scattered <i>Picea mariana</i> and <i>Larix laricina</i> dominate the very open (10–25%) canopy. The understory usually has ericaceous shrubs (including <i>Betula nana</i> , <i>Ledum groenlandicum</i> , <i>Vaccinium vitis-idaea</i> , <i>Oxycoccus microcarpus</i> , <i>Rubus chamaemorus</i> , <i>Sphagnum</i> spp., and <i>Eriophorum vaginatum</i> .
Closed Balsam Poplar Forest	Closed (>60%) stands dominated by young to mid-aged <i>Populus balsamifera</i> . The understory includes <i>Picea glauca</i> , <i>Rosa acicularis</i> , <i>Calamagrostis canadensis</i> , and <i>Equisetum arvense</i> .
Closed Paper Birch Forest	Closed stands of <i>Betula papyrifera</i> ; spruce may occur in the understory. In the uplands, the understory includes <i>Alnus crispa</i> , <i>Rosa acicularis</i> , <i>Viburnum edule</i> , <i>Cornus canadensis</i> , <i>Equisetum arvense</i> , and <i>Calamagrostis</i> spp. In the lowlands, <i>Ledum groenlandicum</i> and <i>Vaccinium vitis-idaea</i> are common.
Closed Quaking Aspen Forest	Small, closed stands of <i>Populus tremuloides</i> are found on south-facing well-drained slopes. The understory has <i>Rosa acicularis</i> , <i>Shepherdia canadensis</i> , <i>Linnaea borealis</i> , and <i>Arctostaphylos uva-ursi</i> .
Closed Paper Birch–Quaking Aspen Forest	Young to mid-aged mixed stands of <i>Betula papyrifera</i> and <i>Populus tremuloides</i> occur on south-facing slopes, and white spruce often is in the understory. The understory generally has shrubs ( <i>Alnus crispa</i> , <i>Rosa acicularis</i> , <i>Shepherdia canadensis</i> , <i>Vaccinium vitis-idaea</i> ), grasses, and club mosses.
Closed Quaking Aspen–Balsam Poplar Forest	Closed, mixed stands of <i>Populus tremuloides</i> and <i>Populus balsamifera</i> can be found in isolated pockets and transitional areas. <i>Betula papyrifera</i> also may be present in small numbers.
Open Paper Birch Forest	Open (<60% canopy cover) of young to mid-aged stands of <i>Betula papyrifera</i> . The understory consists of <i>Alnus crispa</i> , or <i>Ledum groenlandicum</i> , <i>Calamagrostis canadensis</i> , and leaf litter.



**Table 5 (cont'd). Description of vegetation types (Level IV, Alaska Vegetation Classification) found on Ft. Wainwright, central Alaska, 1998. For more complete descriptions see Viereck et al. (1992).**

Class	Description
Open Paper Birch–Quaking Aspen Forest	Mid-successional stands with an open (<60%) canopy of <i>Betula papyrifera</i> and <i>Populus tremuloides</i> . The understory has tall shrubs ( <i>Alnus crispa</i> and <i>Salix</i> spp.), and the grass <i>Calamagrostis canadensis</i> .
Broadleaf–Shrub Woodland	This class is an early successional stage after fire or other disturbance. Young <i>Betula papyrifera</i> trees and saplings occur with a mixture of tall shrubs (primarily <i>Salix</i> spp.), low shrubs, and grasses.
Closed Spruce–Paper Birch Forest	Closed, mixed stands of <i>Betula papyrifera</i> and <i>Picea glauca</i> or <i>Picea mariana</i> . The understory usually has <i>Alnus crispa</i> , <i>Salix bebbiana</i> , <i>Rosa acicularis</i> , <i>Calamagrostis canadensis</i> , <i>Cornus canadensis</i> , and <i>Equisetum arvense</i> or <i>Vaccinium vitis-idaea</i> and feather mosses.
Closed Spruce–Paper Birch–Quaking Aspen Forest	Closed, mixed stands of <i>Picea glauca</i> , <i>Picea mariana</i> , <i>Betula papyrifera</i> , and <i>Populus tremuloides</i> that typically occur on upland, south-facing slopes. The understory has <i>Salix</i> spp., <i>Viburnum edule</i> , <i>Vaccinium vitis-idaea</i> , <i>Mertensia paniculata</i> , and mosses.
Closed Quaking Aspen–Spruce Forest	This type is transitional between <i>Picea glauca</i> and <i>Populus tremuloides</i> stands and generally occurs on south-facing slopes.
Closed Balsam Poplar–White Spruce Forest	A mid-successional stage, with <i>Picea glauca</i> and <i>Populus balsamifera</i> forming a closed canopy. The understory has <i>Alnus tenuifolia</i> , <i>Rosa acicularis</i> , <i>Vaccinium vitis-idaea</i> and <i>Equisetum arvense</i> .
Open Spruce–Paper Birch Forest	Open, young to mid-aged stands of <i>Betula papyrifera</i> and <i>Picea glauca</i> . The understory has <i>Salix</i> spp., <i>Viburnum edule</i> , <i>Vaccinium vitis-idaea</i> , <i>Mertensia paniculata</i> , <i>Calamagrostis canadensis</i> , and mosses.
Open Quaking Aspen–Spruce Forest	<i>Populus tremuloides</i> and <i>Picea</i> spp. are found growing together on better-drained lowland areas. This is a successional community, where the spruce are likely to overtop the aspen.
Open Spruce–Balsam Poplar Forest	Similar to Closed Balsam Poplar–White Spruce Forest, this type often is older and decadent balsam poplar are being replaced in the canopy by white spruce. A dense carpet of feather mosses is common.
Open Black Spruce Dwarf Tree Scrub	Open stands of dwarf <i>Picea mariana</i> (shorter than 3 m) with occasional <i>Larix laricina</i> . The understory has ericaceous shrubs, sedges ( <i>Eriophorum vaginatum</i> ), <i>Sphagnum</i> spp., and feather mosses.
Closed Tall Willow Scrub	Tall (>1.5 m) <i>Salix alaxensis</i> , <i>Salix interior</i> , <i>Salix glauca</i> , and other <i>Salix</i> spp. form a closed (>75%) canopy. This class generally is an early successional stage on river bars or after fires.
Closed Tall Alder Shrub	Tall alder ( <i>Alnus tenuifolia</i> , <i>A. crispa</i> ) form dense thickets along rivers and after fire in the uplands.
Closed Tall Alder–Willow Shrub	Tall (>1.5 m) alder ( <i>Alnus tenuifolia</i> , <i>A. crispa</i> ) and willows ( <i>Salix alaxensis</i> , <i>Salix bebbiana</i> ) form dense thickets along rivers and after fire in the uplands. Understory species include tree saplings and <i>Equisetum arvense</i> . Subalpine sites have <i>Spiraea Beauverdiana</i> , <i>V. uliginosum</i> and <i>Petasites frigidus</i> .
Open Tall Willow Shrub	Tall <i>Salix alaxensis</i> , <i>Salix interior</i> , <i>Salix glauca</i> , and other <i>Salix</i> spp. form an open canopy. This class generally is an early successional stage on river bars.
Open Tall Alder Shrub	Tall (>1.5 m) alder ( <i>Alnus tenuifolia</i> , <i>A. crispa</i> ) in open thickets along rivers and after fire on uplands.
Open Tall Shrub Swamp	<i>Alnus tenuifolia</i> , <i>Salix planifolia</i> , and <i>S. bebbiana</i> form an open canopy with occasional <i>Betula papyrifera</i> over <i>Carex aquatilis</i> , <i>Calamagrostis canadensis</i> , <i>Potentilla palustris</i> , and <i>Equisetum fluviatile</i> in wet areas.
Closed Low Shrub Birch–Willow Shrub	These closed, low (0.2–1.5 m tall) shrub communities are dominated by dwarf birch ( <i>Betula nana</i> ), and willows ( <i>Salix planifolia</i> and <i>Salix glauca</i> ).
Closed Low Shrub Birch–Ericaceous Shrub	<i>Betula nana</i> is dominant. Also present are <i>Chamaedaphne calyculata</i> , <i>Ledum groenlandicum</i> , <i>Vaccinium uliginosum</i> , <i>Eriophorum</i> spp., <i>Carex bigelowii</i> , and <i>Calamagrostis canadensis</i> .
Closed Low Shrub	An early successional stage after fire usually dominated by <i>Ledum groenlandicum</i> . Associated species include <i>Picea mariana</i> , <i>Vaccinium uliginosum</i> , other ericaceous shrubs, <i>Salix</i> spp., and feather mosses.
Open Low Mixed Shrub–Sedge Tussock Bog	The open (25–75%) shrub canopy of <i>Betula nana</i> and ericaceous shrubs is punctuated by abundant <i>Eriophorum vaginatum</i> tussocks. Scattered <i>Picea mariana</i> and <i>Larix laricina</i> are common.



Table 5 (cont'd).

Class	Description
Open Low Mesic Shrub Birch–Ericaceous Shrub	<i>Betula nana</i> dominates the open shrub canopy and scattered, dwarf black spruce may be present. Other important species include <i>Ledum decumbens</i> , <i>Vaccinium</i> spp., <i>Carex Bigelowii</i> and lichens.
Open Low Shrub Birch–Ericaceous Shrub Bog	This type is similar to Closed Low Shrub Birch–Ericaceous Shrub, but there are fewer shrubs (<75% cover), while sedges and <i>Sphagnum</i> spp. are more abundant.
Open Low Scrub	A post-fire, early successional stage of open <i>Salix</i> spp., <i>Ledum groenlandicum</i> , <i>Linnaea borealis</i> , and <i>Vaccinium uliginosum</i> , with <i>Calamagrostis canadensis</i> , <i>Ceratodon purpureus</i> , and <i>Polytrichum</i> sp.
Open Low Willow–Graminoid Shrub Bog	<i>Salix planifolia</i> , other willows, and occasional Alder occupy drier microsites, while <i>Carex rostrata</i> , <i>Carex magellanica</i> , <i>Carex aquatilis</i> , and other sedges are common in wetter areas.
Open Low Sweetgale–Graminoid Bog	The open canopy is dominated by <i>Myrica gale</i> . Other common species include <i>Chamaedaphne calyculata</i> , <i>Betula nana</i> , <i>Alnus tenuifolia</i> , <i>Carex aquatilis</i> , and <i>Eriophorum angustifolium</i> .
Dryas–Lichen Dwarf Shrub Tundra	Dominated by an open canopy of the dwarf (<0.2-m) shrub <i>Dryas octopetala</i> , and crustose and fruticose lichens. <i>Betula nana</i> , <i>Arctostaphylos uva-ursi</i> , and <i>Empetrum nigrum</i> are common.
Dry Midgrass–Shrub	Found on steep south-facing bluffs, this type includes include <i>Elymus innovatus</i> , <i>Poa</i> spp., <i>Rosa acicularis</i> , <i>Artemisia frigida</i> , <i>Pulsatilla patens</i> , and <i>Selaginella siberica</i> .
Bluejoint Meadow	Moist meadows dominated by bluejoint reedgrass ( <i>Calamagrostis canadensis</i> ). Associated species include <i>Carex rostrata</i> , <i>Eriophorum angustifolium</i> , and <i>Potentilla</i> spp.
Fresh Sedge Marsh	These uncommon communities of emergent sedges, dominated by <i>Scirpus validus</i> , are found along the edges of lakes or in the center of in-filling lakes. Small patches of <i>Typha latifolia</i> are common.
Subarctic Lowland Sedge–Herb Bog Meadow	This class is found in small thermokarst depressions or in-filling lakes. The vegetation is dominated by coarse sedges (e.g. <i>Carex aquatilis</i> ), <i>Potamogeton</i> spp., and <i>Equisetum fluviatile</i> .
Subarctic Lowland Sedge Wet Meadow	Wet meadows are dominated by coarse sedges ( <i>Carex aquatilis</i> , <i>C. rostrata</i> , and <i>Eriophorum angustifolium</i> ). Associated species include <i>Potentilla palustris</i> and <i>Equisetum fluviatile</i> .
Subarctic Lowland Sedge–Bog Meadow	This wet type is dominated by fine sedges (e.g. <i>Carex canescens</i> , <i>C. limosa</i> , and <i>Eriophorum russeolum</i> ) but often includes some shrubs ( <i>Chamaedaphne calyculata</i> , <i>Salix</i> sp.) and mosses ( <i>Sphagnum</i> spp.).
Subarctic Lowland Sedge–Moss Bog Meadow	This class is characterized by <i>Sphagnum</i> mosses on thick accumulations of peat. Associated plants include <i>Eriophorum scheuchzeri</i> , <i>Carex rariflora</i> , <i>Andromeda polifolia</i> , and <i>Oxycoccus microcarpus</i> .
Fresh Herb Marsh	Areas of deep water dominated by <i>Equisetum fluviatile</i> , <i>Menyanthes trifoliata</i> , and <i>Calla palustris</i> .
Subarctic Lowland Herb Bog Meadow	Minerotrophic fens dominated by <i>Menyanthes trifoliata</i> , <i>Potentilla palustris</i> , <i>Carex rostrata</i> , and <i>Equisetum fluviatile</i> .
Fresh Pondweed	Some ponds support plant communities dominated by <i>Potamogeton</i> spp. Associated species can include <i>Lemna minor</i> , <i>Hippuris vulgaris</i> , and <i>Myriophyllum verticillatum</i> .
Lowland Eolian Complex	Complex mosaic of terrain unit types (lowland eolian deposits, organic bogs and isolated sand dunes) that support Open Black Spruce Forest, Closed Paper Birch Forest, Open Low Shrub Birch–Ericaceous Shrub Bog, Open Low Mixed Shrub–Sedge Tussock Bog, and Bluejoint Meadows.
Riverine Complex	Mosaic of small communities on river floodplains that can include closed tall shrub types, Closed Balsam Poplar Forest, Closed Balsam Poplar–White Spruce Forest, and Closed White Spruce Forests.
Slope Drainage Complex	Complex mosaic of vegetation types caused by variable drainage conditions on lower slopes. Open Black Spruce Forests are interrupted by linear features of Closed Tall Alder Shrub and Closed Paper Birch Forests on slopes and Open Low Shrub Birch–Ericaceous Shrub Bogs on flats.
Paludification Complex	This class is found in slow, diffuse drainages on the Tanana Flats. Vegetation is composed of several types dominated by wet sedge ( <i>Carex aquatilis</i> , <i>Carex rostrata</i> ), forbs ( <i>Equisetum fluviatile</i> , <i>Typha latifolia</i> , <i>Caltha palustris</i> ) and patches of floating fen ( <i>Menyanthes trifoliata</i> , <i>Potentilla palustris</i> ).

**Table 5 (cont'd). Description of vegetation types (Level IV, Alaska Vegetation Classification) found on Ft. Wainwright, central Alaska, 1998. For more complete descriptions see Viereck et al. (1992).**

<i>Class</i>	<i>Description</i>
Thermokarst Complex (Open Paper Birch– Shrub Birch–Fen)	This vegetation complex is related to collapse scar fen creation and includes Closed Paper Birch Forests, Open Low Shrub Birch–Ericaceous Shrub Bogs, and Subarctic Lowland Herb Bog Meadow.
Thermokarst Complex (Open Paper Birch– Shrub Swamp–Fen)	This complex is similar to the Open Paper Birch Thermokarst Complex above. However, unlike that association, Open Tall Shrub Swamp frequently forms a border at the edges of fens in this class where shrubs and forest are actively collapsing into the fens.
Thermokarst Complex (Black Spruce–Bog)	This complex is related to thermokarst processes and is dominated Open Black Spruce Forests with circular thermokarst depressions that support Lowland Subarctic Sedge–Moss Bog Meadows.
Thermokarst Complex (Closed Paper Birch– Collapse Bog)	This complex is related to thermokarst processes and is dominated Closed Paper Birch Forest and circular thermokarst depressions. Depressions have moats at the periphery (Fresh Herb Marsh), and Lowland Subarctic Wet Sedge Meadows or Lowland Subarctic Sedge–Moss Bog Meadows.
Thermokarst Complex (Mixed Spruce–Paper Birch–Collapse Bog)	This complex is similar to the Closed Paper Birch–Collapse Bog above, but the forest type is Mixed Spruce–Paper Birch.
Thermokarst Complex (Open Paper Birch– Shrub Birch–Collapse Bog)	This complex mosaic is related to thermokarst processes and is dominated by Open Paper Birch Forest and Closed Low Shrub Birch–Ericaceous Shrub on frozen areas and Lowland Subarctic Sedge–Moss Bogs Meadows in circular thermokarst depressions.
Barren	Vegetation covers less than 5% of the soil surface.
Partially Vegetated	Vegetation covers 5–30% of the soil surface.

from accumulations of birch litter and aquatic species, indicating changing ecological conditions during the evolution of the landscape. Adjacent to these elevated birch forests, frequently are large, linear collapse-scar fens associated with groundwater discharge that include several stages of paludification. These stages include the "moat" formed immediately adjacent to the collapsing banks, large expanses of buckbean and swamp horsetail, and slightly raised areas with willows, alder, and sweet gale. In contrast, in more stable areas where thermokarst is less prevalent, black spruce forests and low shrub birch–ericaceous shrublands are more common (Fig. 10 and 22).

Within the Tanana Floodplain Ecodistrict, the geomorphology is dominated by erosional and depositional processes associated with braided or meandering rivers, in contrast to the thermal, permafrost-related processes dominating the Tanana Flats Ecodistrict. Geomorphic units include braided or meandering riverbed deposits and active- and inactive-cover deposits (Fig. 12). Riverbed deposits have gravelly material, are flooded every year or two, and generally are barren or partially vegetated due to the frequent disturbance. Active-cover deposits occur along the mar-

gins of active channels, have frequent silt deposition due to flooding approximately every 2–5 years, and support tall alder–willow and young balsam poplar communities. In contrast, inactive-cover deposits have interbedded silt and organic layers near the surface, which are indicative of infrequent flooding, and they typically support balsam poplar and white spruce forests.

Within the White Mountains Ecodistrict, the geomorphology is dominated by residual soils over weathered bedrock, but also includes smaller areas with a loess cap near the Tanana River, retransported deposits on lower slopes, veneer bogs on retransported deposits, and narrow headwater floodplains (Fig. 17–21). Generally, upland areas with residual soils have vegetation that follows a successional sequence after fire evolving from herb and shrub stages to deciduous forest, mixed forest, and, finally, white spruce and black spruce stages. Retransported deposits are dominated by black spruce forest, but have occasional patches of birch forest, willow and ericaceous shrub lands, and low shrub–tussock meadows. Smaller headwater streams are dominated by riverine willow vegetation, but occasionally include spruce and birch forest combinations.

**Table 6. Areal extent of vegetation types within Yukon Maneuver Area (YMA) and Tanana Flats (Flats) portions of Ft. Wainwright, central Alaska, 1998.**

Vegetation class	Flats		YMA		Total	
	area (ha)	%	area (ha)	%	area (ha)	%
Barren (<5% vegetated)	375	0.1	322	0.3	697	0.2
Water (<5% vegetated)	2805	1.1	118	0.1	2805	0.8
Partially Vegetated (>5,<30% cover)	473	0.2	212	0.2	685	0.2
Closed White Spruce Forest	3321	1.3			3321	0.9
Closed Black Spruce Forest	19,978	7.6	777	0.7	20,756	5.6
Closed Black Spruce-White Spruce Forest	6374	2.4			6374	1.7
Open White Spruce Forest	289	0.1			289	0.1
Open Black Spruce Forest	34,364	13.0	25,794	24.7	60,158	16.3
Open Black Spruce-Tamarack Forest	10,827	4.1			10,827	2.9
Open Black Spruce-White Spruce Forest	363	0.1	3794	3.6	4157	1.1
Open Black Spruce (South-facing)			1586	1.5	1586	0.4
Mixed Conifer Woodland	8069	3.1	939	0.9	9008	2.4
Closed Balsam Poplar Forest	2561	1.0	13	0.0	2574	0.7
Closed Paper Birch Forest	1690	0.6	3112	3.0	4802	1.3
Closed Quaking Aspen Forest	126	0.0			126	0.0
Closed Paper Birch-Quaking Aspen Forest	630	0.2	11,382	10.9	12,012	3.3
Open Paper Birch Forest	448	0.2	1346	1.3	1793	0.5
Open Paper Birch-Quaking Aspen Forest	336	0.1	4119	3.9	4454	1.2
Broadleaf-Scrub Woodland	1953	0.7	2058	2.0	4011	1.1
Closed Spruce-Paper Birch Forest	11,741	4.4	12,230	11.7	23,971	6.5
Closed Spruce-Paper Birch-Quaking Aspen Forest	2113	0.8	10,652	10.2	12,765	3.5
Closed Balsam Poplar-White Spruce Forest	1643	0.6	47	0.0	1690	0.5
Open Spruce-Paper Birch Forest	2708	1.0	9304	8.9	12,012	3.3
Open Quaking Aspen-Spruce Forest	466	0.2			466	0.1
Closed Tall Alder-Willow Shrub	5342	2.0	2529	2.4	7871	2.1
Open Tall Shrub Swamp	4873	1.8			4873	1.3
Closed Low Shrub Birch-Ericaceous Shrub	22,406	8.5	659	0.6	23,065	6.3
Closed Low Scrub	12,208	4.6	864	0.8	13,072	3.5
Open Low Mixed Shrub-Sedge Tussock Bog	7610	2.9	1890	1.8	9500	2.6
Open Low Scrub (post burn, disturbance)	397	0.2	831	0.8	1228	0.3
Open Low Willow-Graminoid Shrub Bog	5219	2.0			5219	1.4
Dryas-Lichen Dwarf Shrub Tundra			45	0.0	45	0.0
Midgrass-Shrub	91	0.0			91	0.0
Bluejoint Meadow	21	0.0	34	0.0	55	0.0
Subarctic Lowland Sedge-Herb Bog Meadow	891	0.3	106	0.1	997	0.3
Subarctic Lowland Sedge Wet Meadow	1040	0.4	15	0.0	1056	0.3
Subarctic Lowland Sedge-Moss Bog Meadow	224	0.1	19	0.0	243	0.1
Subarctic Lowland Herb Bog Meadow	2640	1.0			2640	0.7
Lowland Eolian Complex			2303	2.2	2303	0.6
Riverine Complex	953	0.4	2461	2.4	3414	0.9
Slope Drainage Complex	9586	3.6	4942	4.7	14,528	3.9
Paludification Complex, (wet forb-sedge fen)	7708	2.9			7708	2.1
Thermokarst Complex, open birch-shrub birch-fen	29,330	11.1			29,330	8.0
Thermokarst Complex, open birch-shrub swamp-fen	765	0.3			765	0.2
Thermokarst Complex, black spruce-collapse scar bog	21,576	8.2			21,576	5.9
Thermokarst Complex, closed paper birch-collapse scar bog	2946	1.1			2946	0.8
Thermokarst Complex, mixed spruce-paper birch-bog	6412	2.4			6412	1.7
Thermokarst Complex, open birch-shrub-bog	8075	3.1			8075	2.2
<i>Sum</i>	263,964	100.0	104,503	100.0	368,467	100.0

## Vegetation

### Ecological Land Classification

Fort Wainwright, Alaska  
Yukon Maneuver Area

Vegetation (1:25,000)—Vegetation map identifies communities dominated by characteristic plant species or groups of species. Classification is based on the Alaska Vegetation Classification (Viereck et al. 1992).



Figure 6. Map of vegetation classes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.

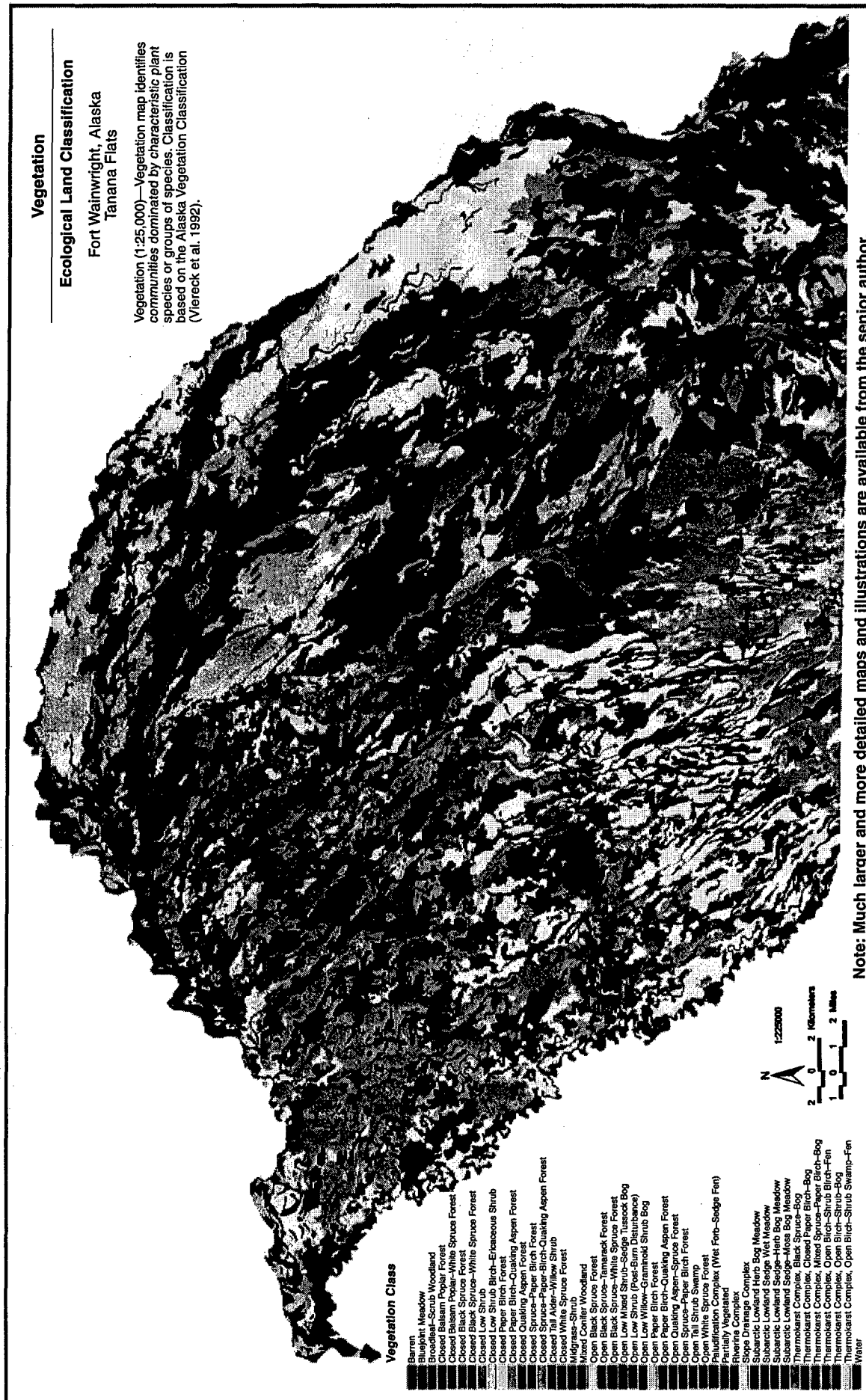


Figure 7. Map of vegetation classes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998.

## Ft. Wainwright Soil Fill Patterns






















Soil Matrix Fill Patterns	Ice Fill Patterns
 Organic with, or without, trace silt (RT, Fb, H, S, etc.)	 Ice
 Organic-mineral (OL) fibric/loamy, sand, peaty silt, mucky loam	 Ice-structureless
 Interbedded peat and silt (OL)	 Ice (>50%) with inclusions
 Silt and silt loam (ML)	 Silt (>50%) with reticulate ice
 Interbedded silt and sand (SM)	 Silt (>50%) with layered ice
 Sand (Clean, SP)	 Silt or sand (<50%) with lenticular ice
 Sand with fines (SM, Sat, ESa, L)	 Organic (<50%) with lenticular ice
 Sand/clay mixtures (SC, CSSa, and CL)	
 Silty clay loam and clay (MH, CH)	
 Silt/sand mixtures with trace gravel (SM)	
 Gravel (Dirty; GM, GC, GCSa, GCL, GSIL)	
 Gravel (Clean; GW, GF)	
 Angular gravel with silt/sand	
 Weathered bedrock	

Figure 8. Soil texture and cryostructures that were used in classifying stratigraphy of geomorphic units along toposequences, Ft. Wainwright, central Alaska, 1998.

Hierarchical associations among ecosystem components. Hierarchical relationships among ecosystem components were developed by successively grouping data from survey plots by physiography, soil texture, geomorphology, slope position, drainage, vegetation structure, and vegetation composition (Table 7). Frequently, geomorphic units with similar texture or genesis were grouped (e.g., *rocky* and *loamy* were grouped for most uplands, and *loamy* and *organic* were grouped for some lowlands) to make the table more compact.

Ecotypes then were derived from these tabular associations to differentiate ecosystems that have different sets of associated characteristics. The nomenclature for ecosystems is intended to convey these characteristics by including descriptors for physiographic, texture (loamy if not explicitly mentioned), moisture, and vegetation structure.

This hierarchical grouping reveals close associations among soil texture, geomorphology, slope position, drainage, and soils, but several vegetation types occur on a geomorphic unit or soil type.

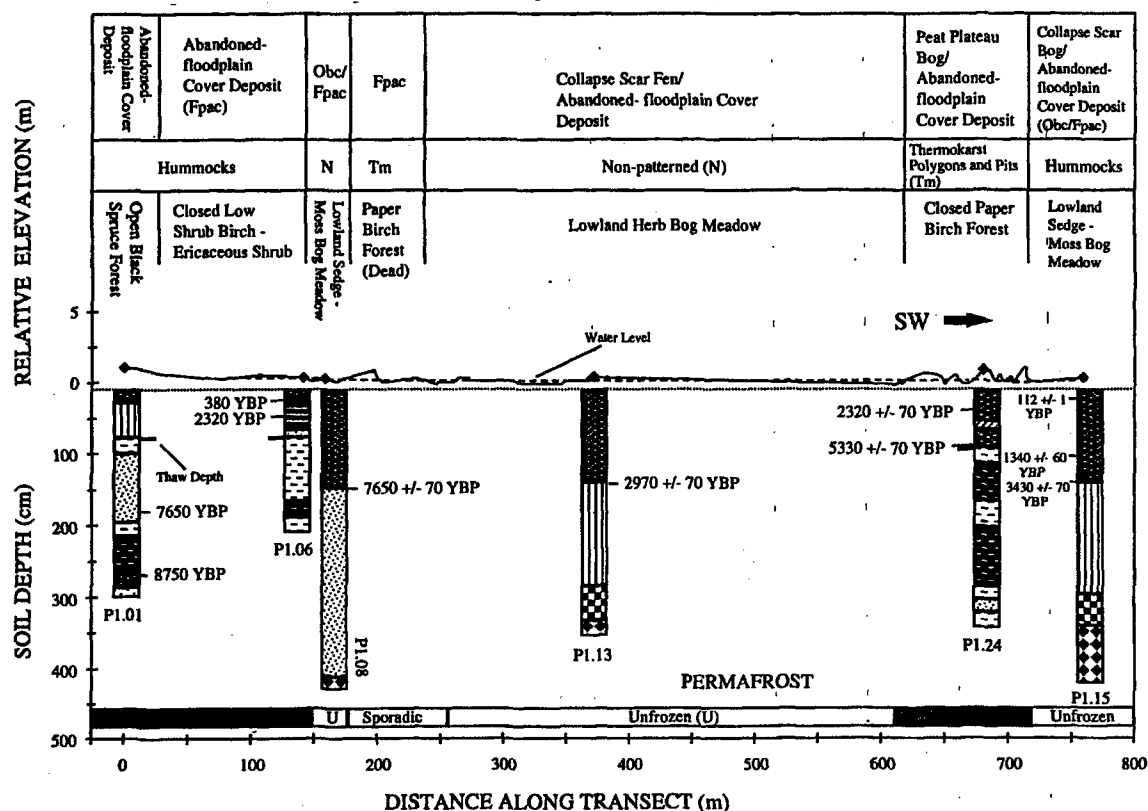


Figure 9. Toposequence (transect 1) in the Willow Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Ft. Wainwright, central Alaska, 1998 (see Fig. 2).

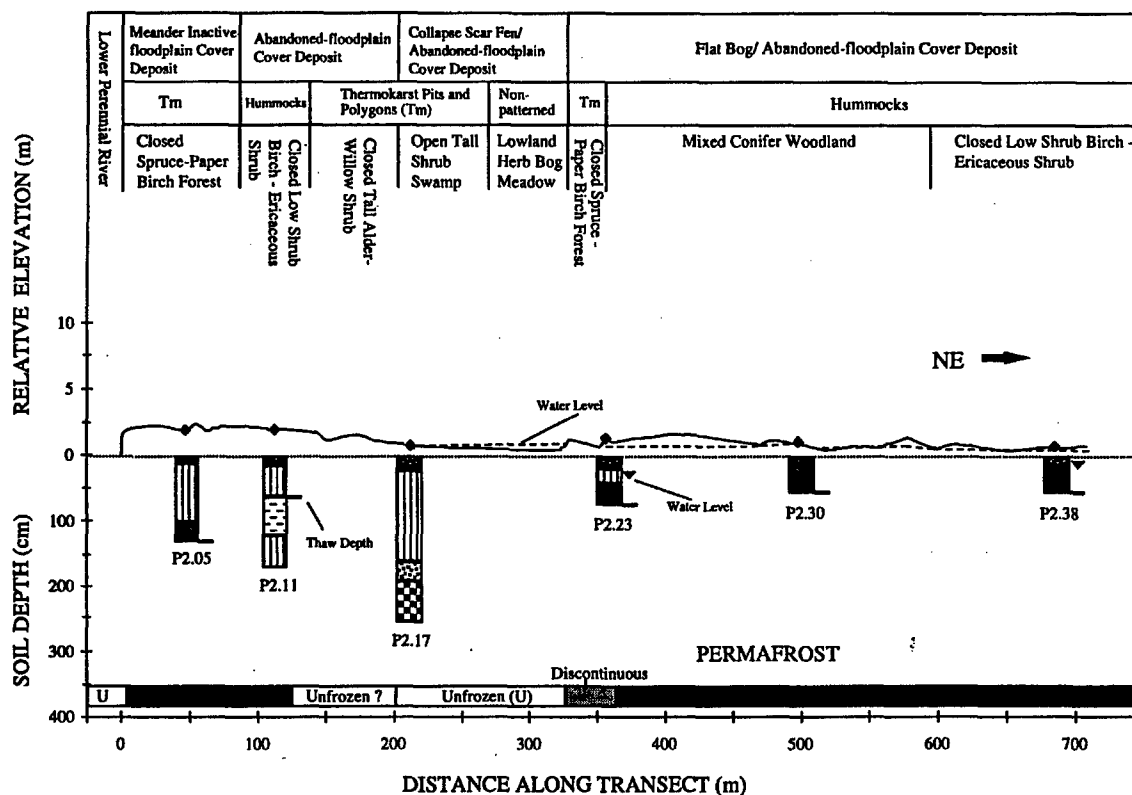


Figure 10. Toposequence (transect 2) in the Clear Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

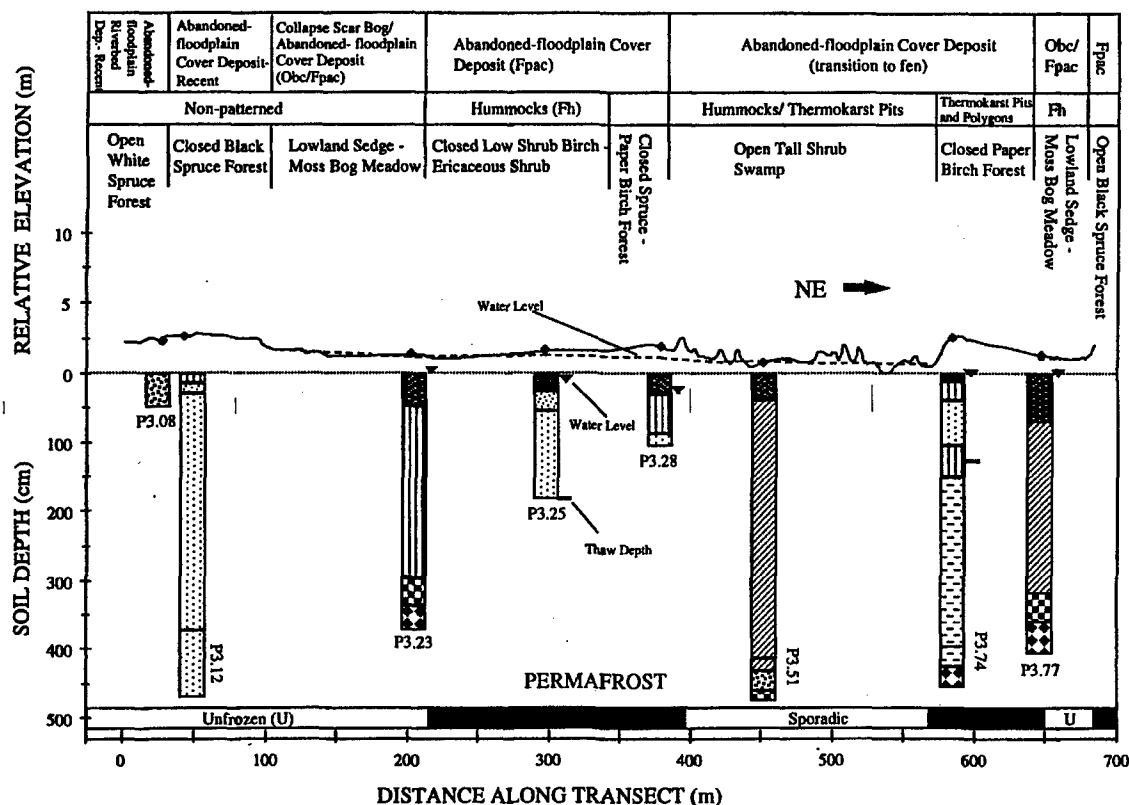


Figure 11. Toposequence (transect 3) in the Willow Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

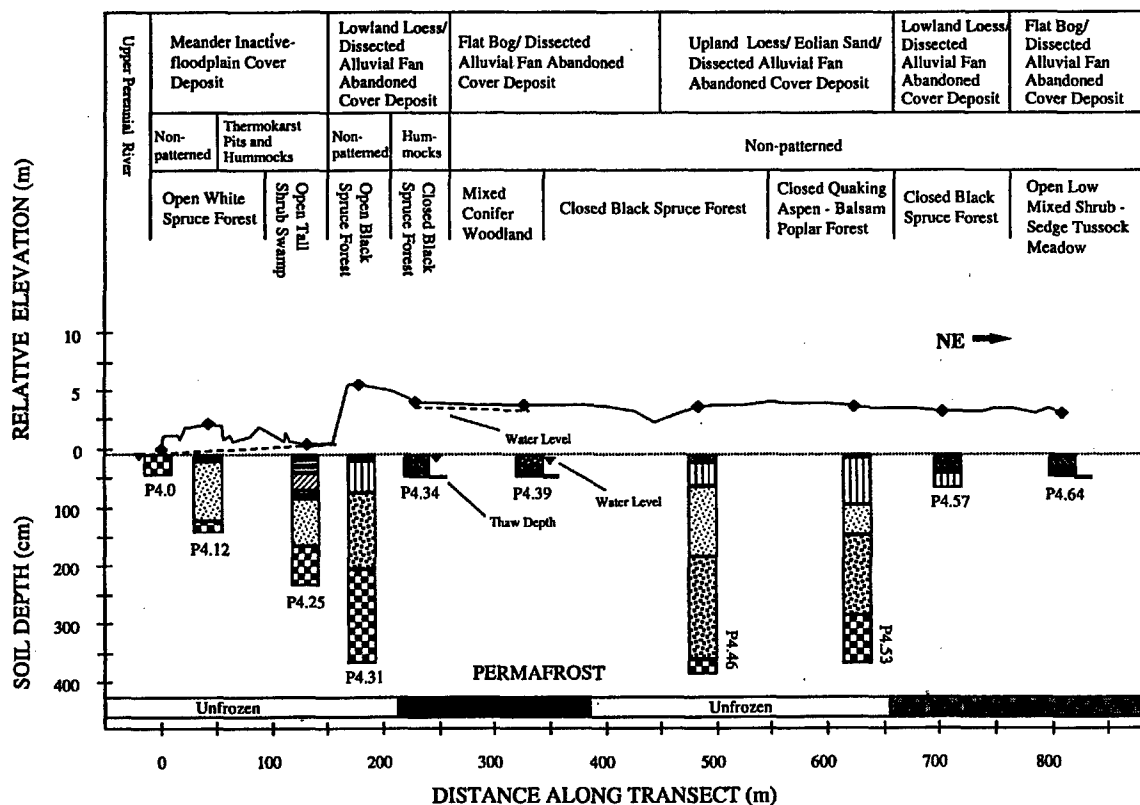


Figure 12. Toposequence (transect 4) in the Dry Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.



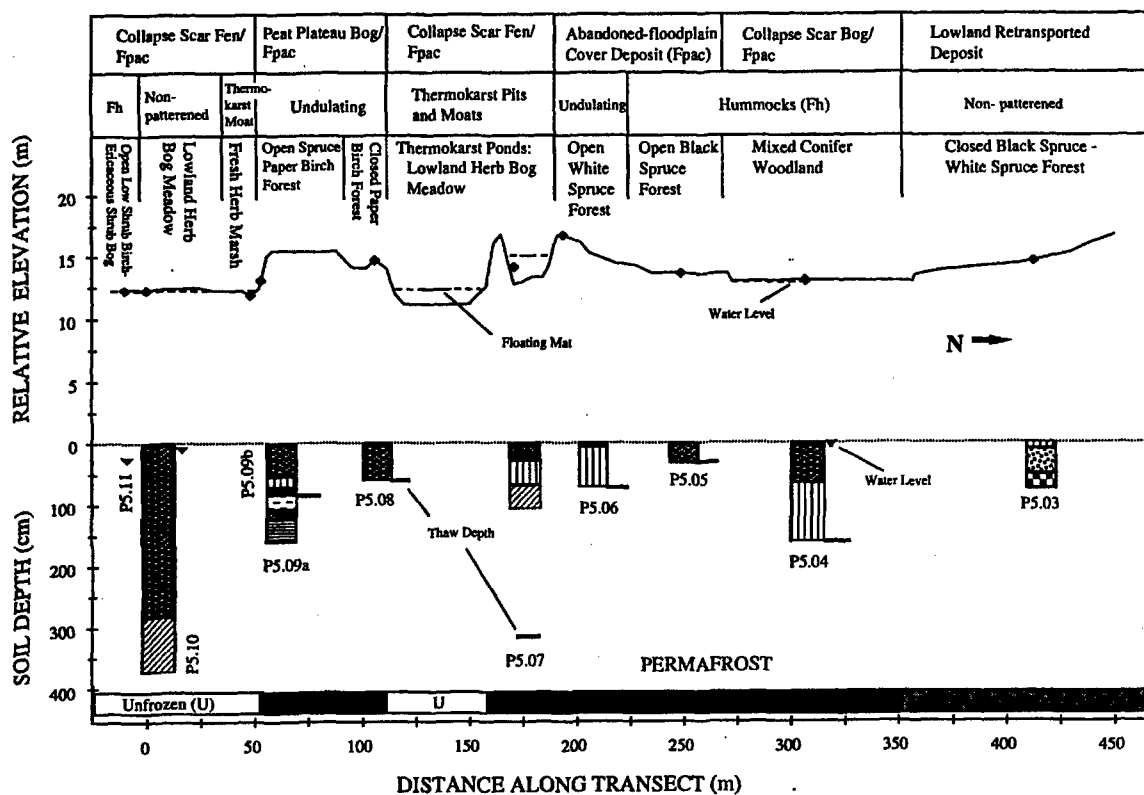


Figure 13. Toposequence (transect 5-south) on the Wood River Buttes portion of the Tanana-Wood River Uplands, illustrating Geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

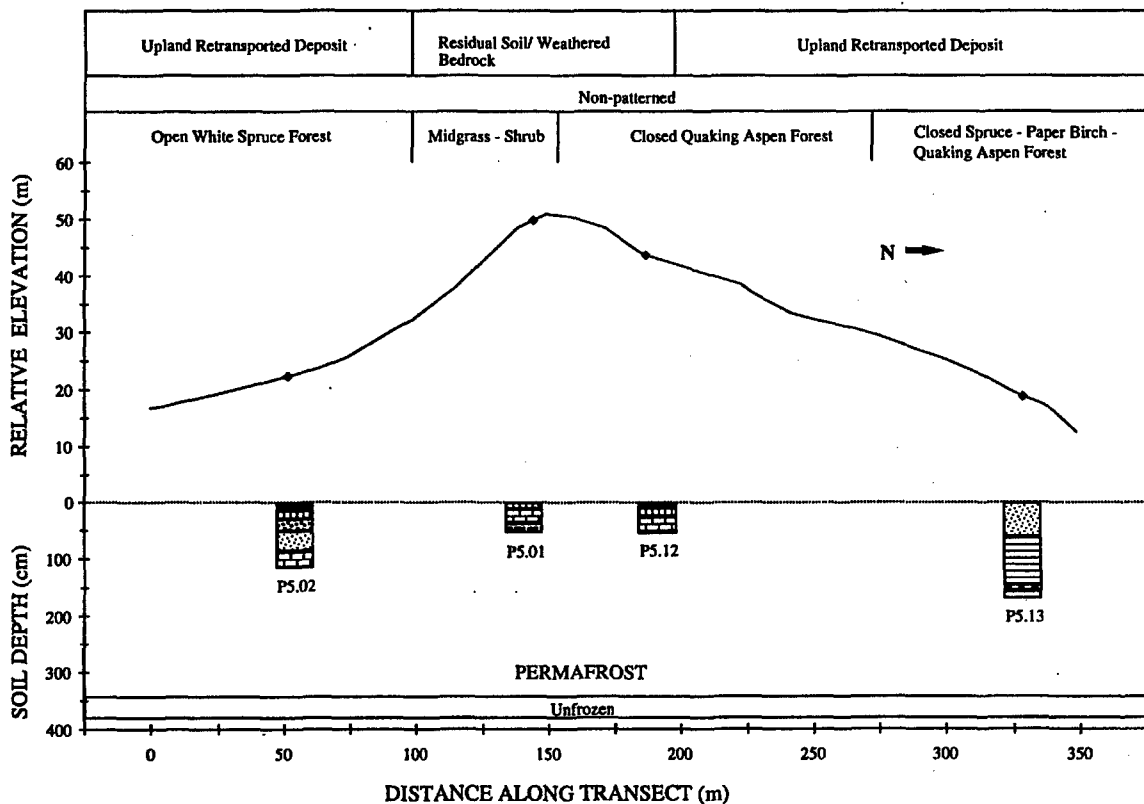


Figure 14. Toposequence (transect 5-butte) on the Wood River Buttes portion of the Tanana-Wood River Uplands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, Alaska, central Alaska, 1998.

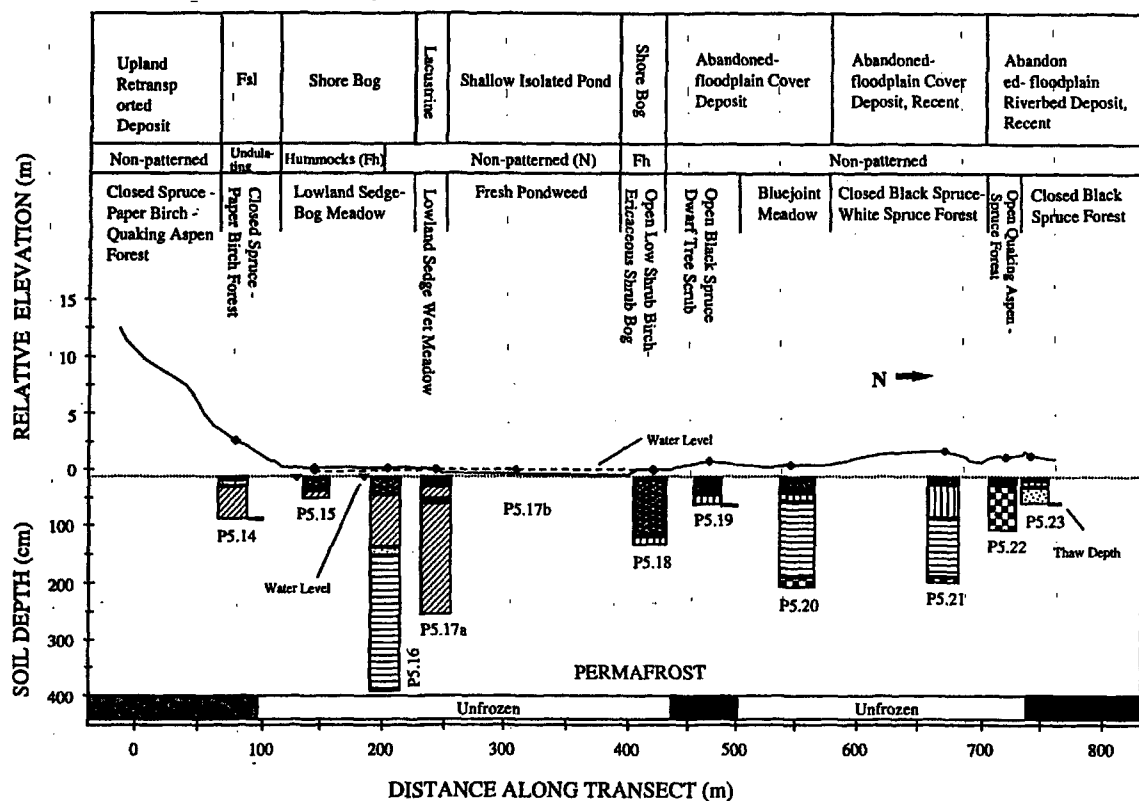


Figure 15. Toposequence (transect 5-north) on the Wood River Buttes portion of the Tanana-Wood River Uplands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, Alaska, central Alaska, 1998.

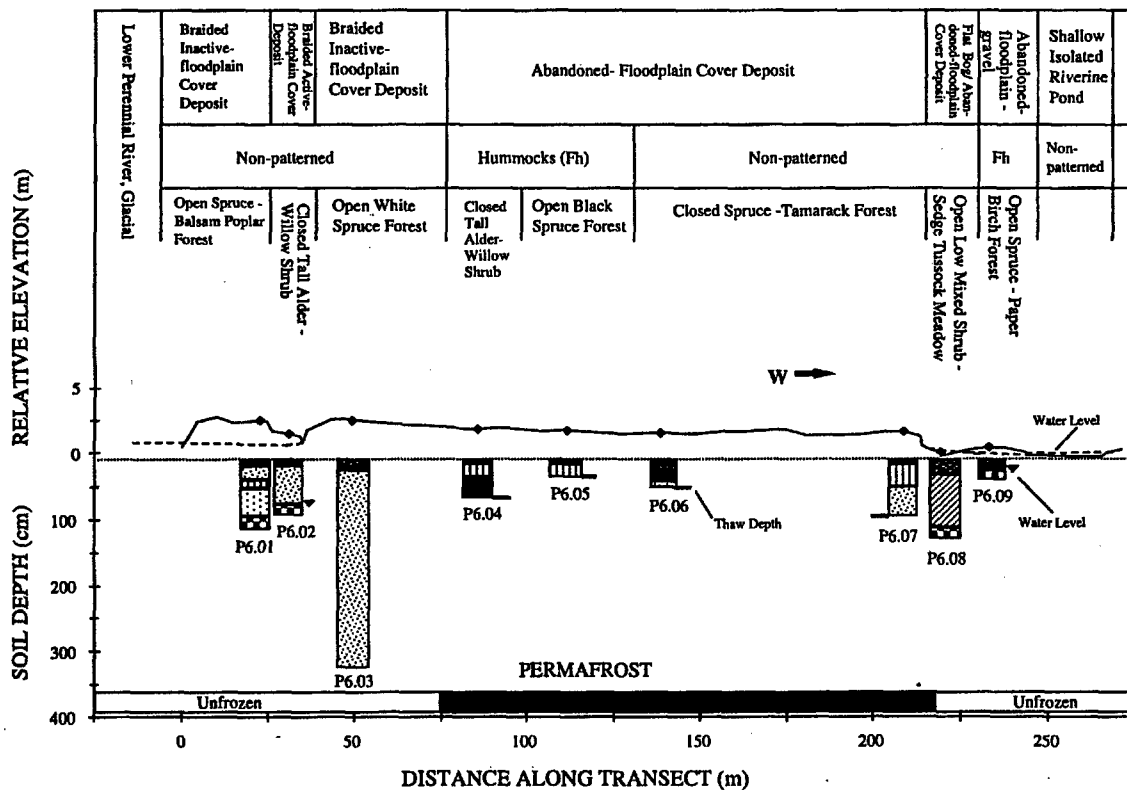


Figure 16. Toposequence (transect 6) in the Eielson-Tanana Floodplain, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

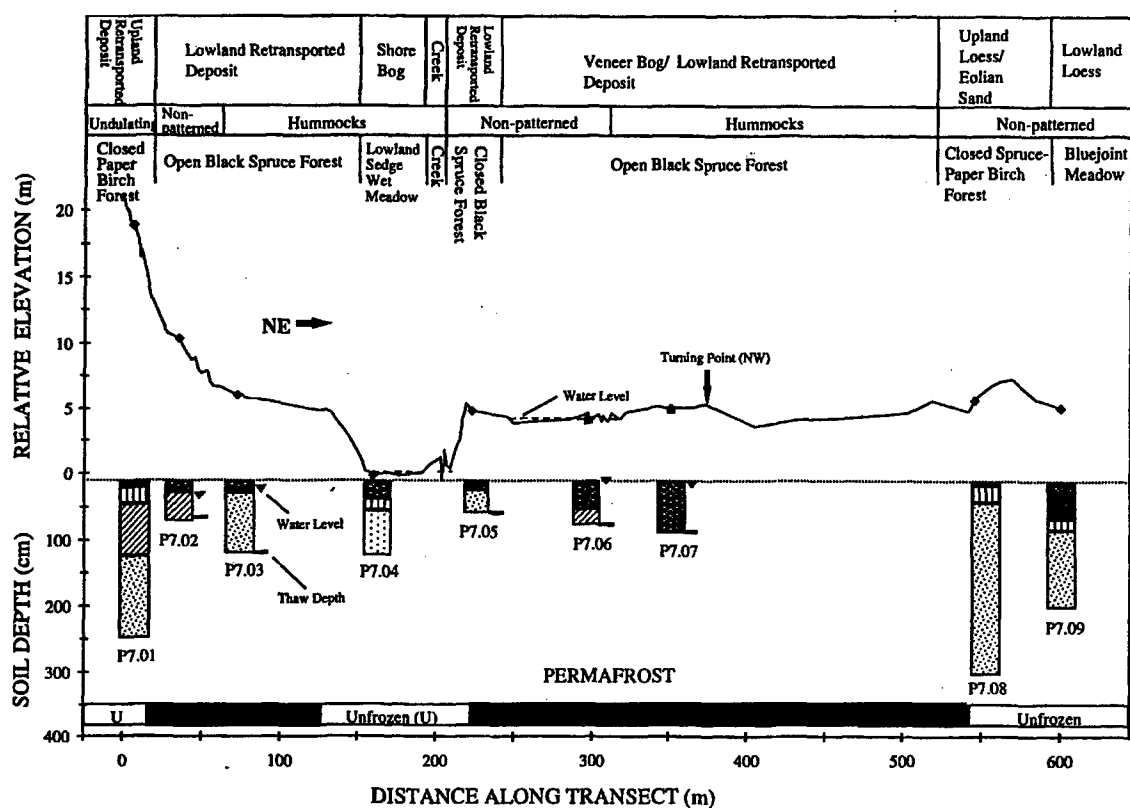


Figure 17. Toposequence (transect 7) in the French-Moose Creek Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

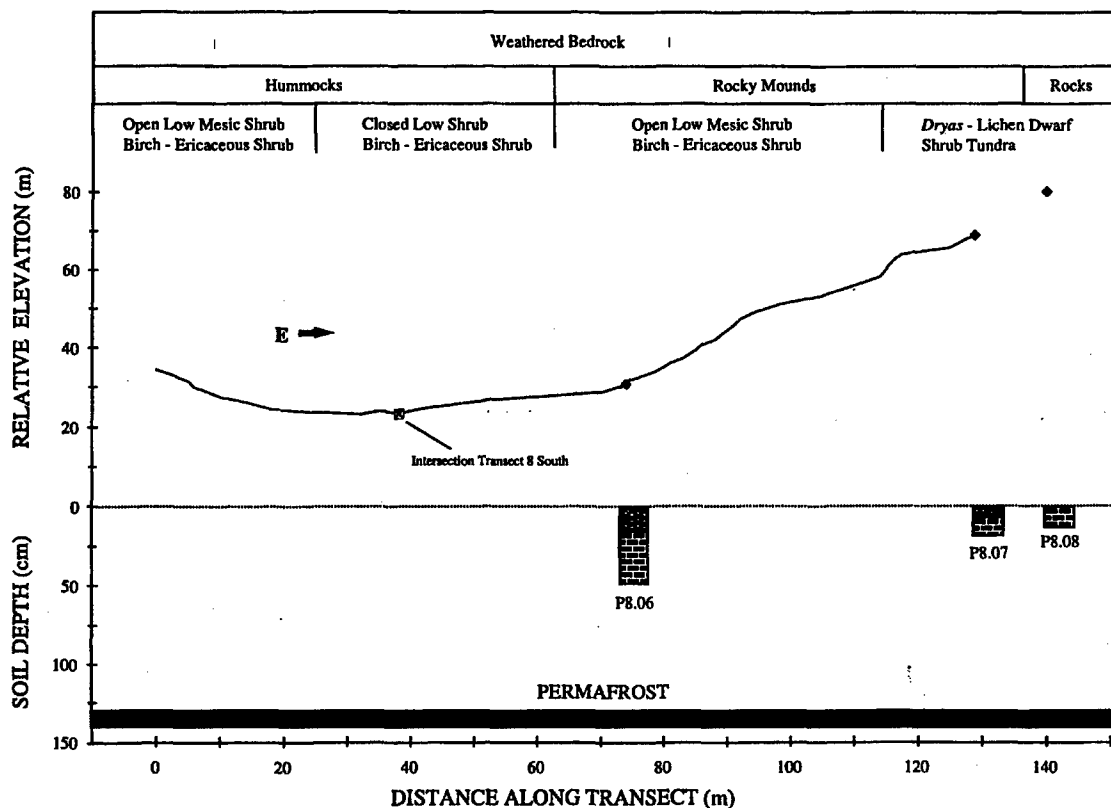


Figure 18. Toposequence (transect 8-east) in the Chena-Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

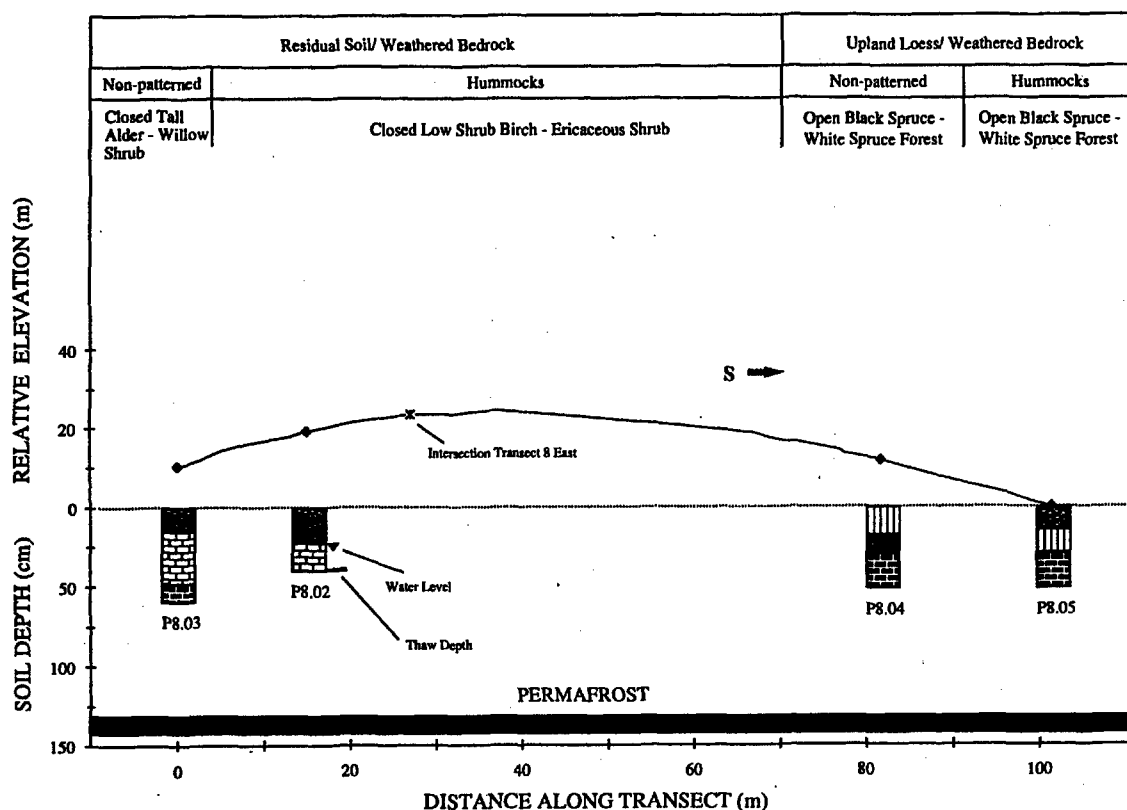


Figure 19. Toposequence (transect 8-south) in the Chena-Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

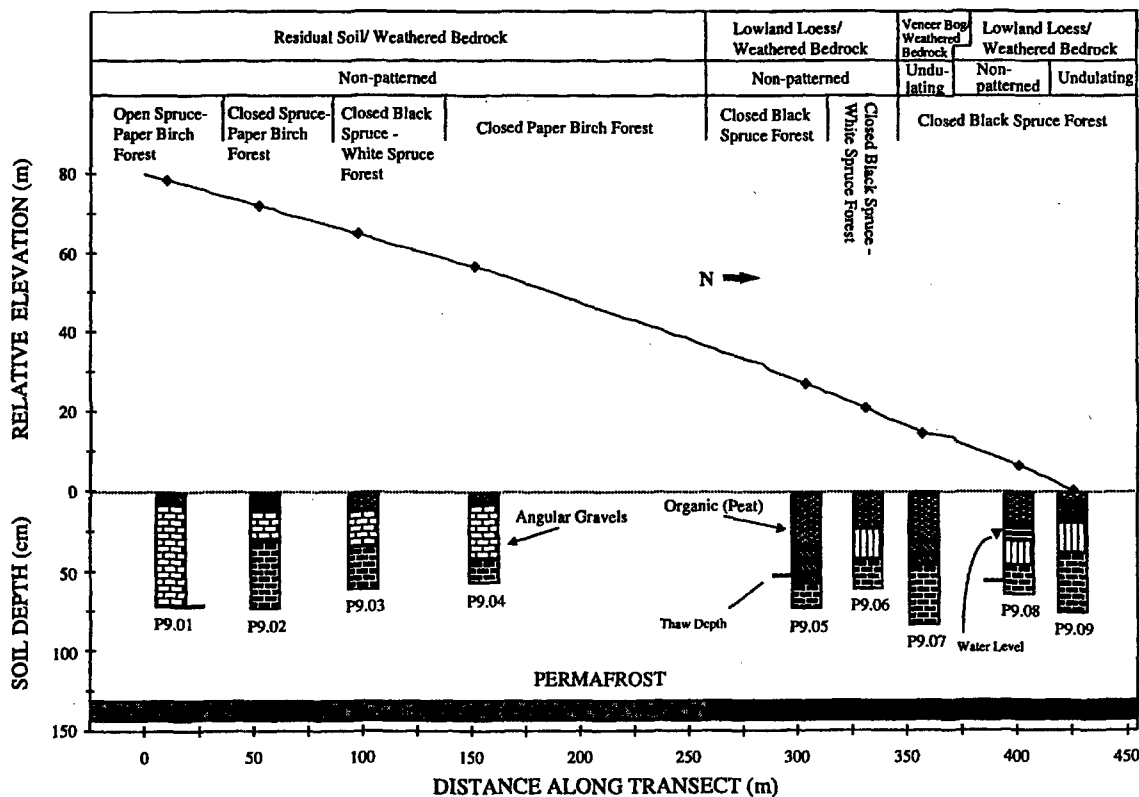


Figure 20. Toposequence (transect 9) in the Chena-Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

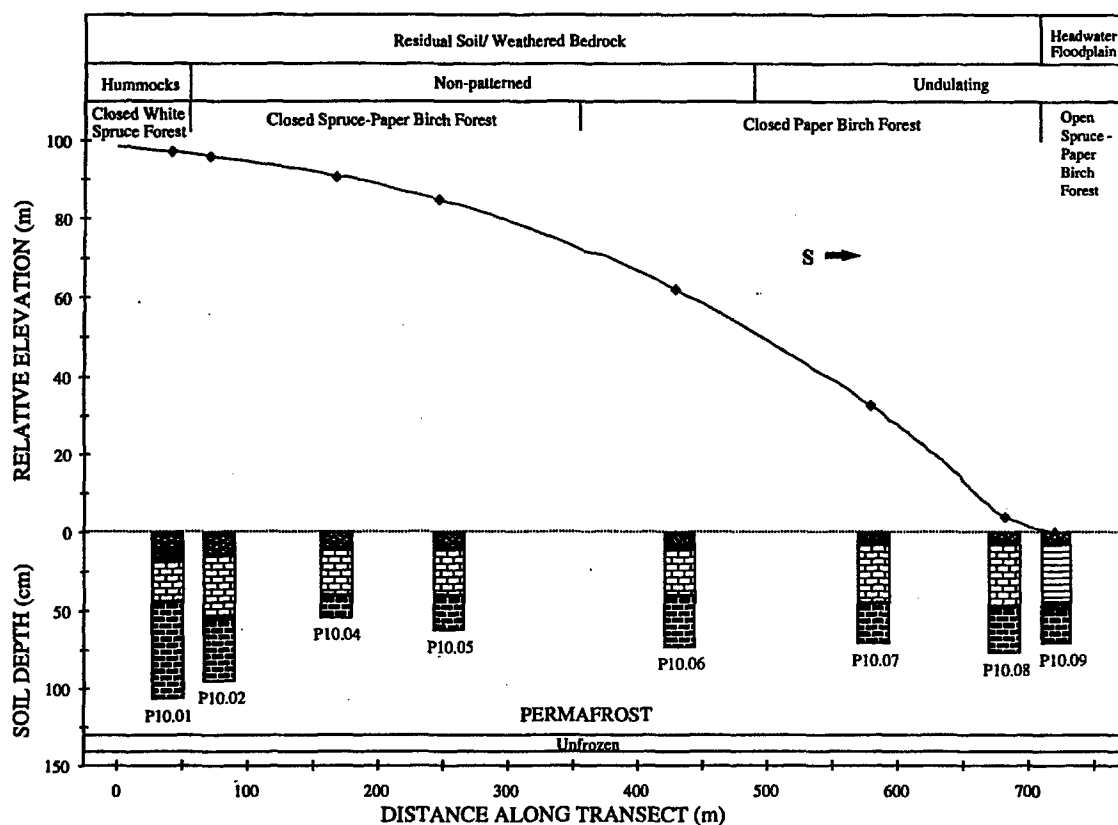


Figure 21. Toposequence (transect 10) in the Chena-Salcha Highlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

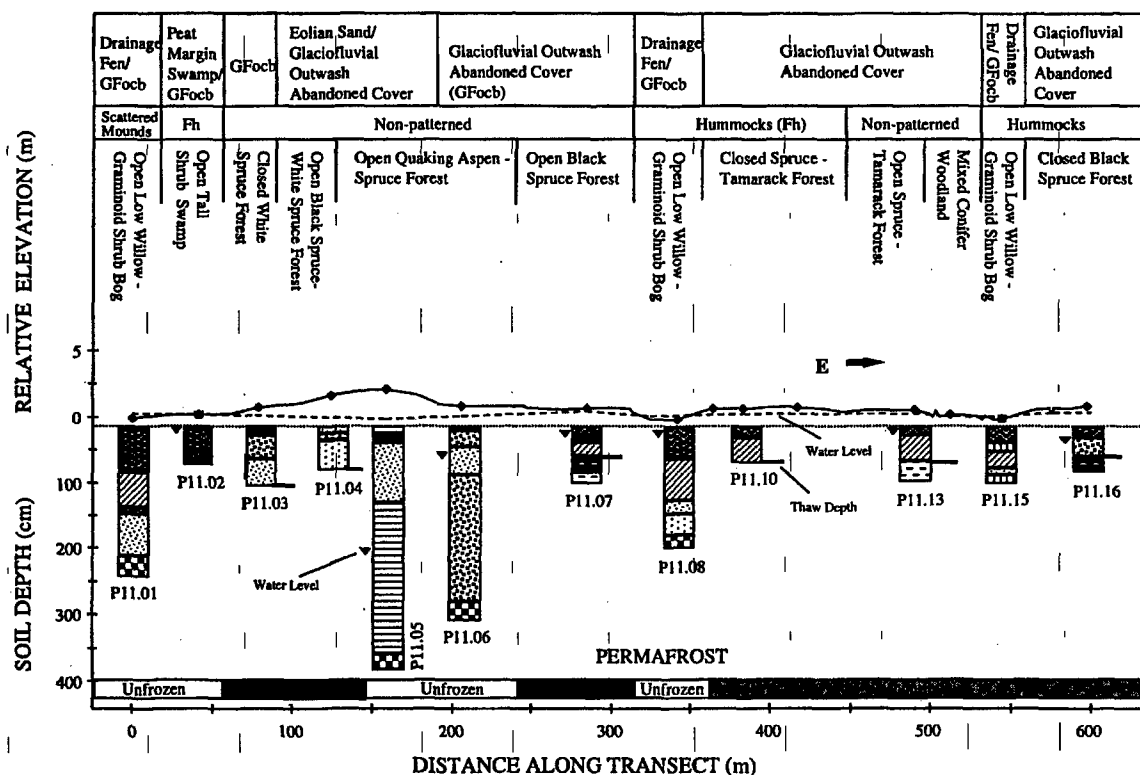


Figure 22. Toposequence (transect 11) in the Wood River Lowlands, illustrating geomorphology, surface form, vegetation, relative elevation, soil stratigraphy, and permafrost, Fort Wainwright, central Alaska, 1998.

Table 7. Hierarchical relationships among ecosystem components for ecosystems found within Ft. Wainwright, Alaska, 1996.

Physiography	Soil texture	Geomorphology	Slope position	Drainage	Soil Subgroup	Permafrost	Common Vegetation Structure		Ecotype
							Structure (Lev. II)	Composition (Level IV)	
Alpine climate									
Upland	Rocky	Weathered Bedrock	Upper	Well	Lithic	Unkwn	Dwarf Scrub	Dryas-lichen tundra	Alpine Rocky Dry Dwarf Scrub
					Cryorthents		Low Scrub	Shrub Birch-Ericaceous Shrub	Alpine Rocky Moist Tall and
					L. or Aquic		Tall Scrub	Alder-Willow	Low Scrub
					Cryorthents		Needleleaf For.	Black-White Spruce (treeline)	
Subarctic climate									
Upland	Rocky and Loamy	Residual Soil, Upland Loess, Eolian Sand, Upland Retransported	Upper	Excess Well	L. Eutrocrept	Absent	Dry Graminoid	Midgrass-Shrub	Upland Rocky Dry Meadow
					Lithic or Dystric		Needleleaf	White Spruce Black Spruce	Upland Moist Needleleaf Forest (south-facing)
					Cryepts, Lamellic Eutrocrepts		Mixed Forest	Spruce-Birch-Aspen Quaking Aspen-Spruce Spruce-Birch	Upland Moist Mixed Forest (south-facing) Upland Moist Mixed Forest
					Broadleaf Forest		Broadleaf Forest	Quaking Aspen Paper Birch Paper Birch	Upland Moist Broadleaf Forest (south-facing) Upland Moist Broadleaf Forest
					Tall Scrub		Tall Scrub	Alder-Willow Broadleaf Scrub	Upland Moist Tall Scrub
					Low Scrub		Low Scrub	Mixed shrub (post-burn)	Upland Moist Low Scrub
					Needleleaf Forest		Needleleaf Forest	Black Spruce	Upland Wet Needleleaf Forest
Lowland	Gravel	Human Modified	Flat	Well	Typic Dystrocrept	Absent	Needleleaf Forest	Barren	Human Modified
					Typic		Black Spruce Black Spruce-Tamarack White Spruce	Lowland Gravelly Moist Needleleaf Forest	
					Eutrocrepts		Broadleaf Forest	Paper Birch-Quaking Aspen	Lowland Gravelly Moist Broadleaf Forest
							Mixed Forest	Spruce-Paper Birch Quaking Aspen-Spruce	Lowland Gravelly Moist Mixed Forest
					Aeric and Typic Cryaquept		Low Scrub	Shrub Birch-Ericaceous Shrub Shrub Birch-Willow Shrub Mixed Conifer Woodland	Lowland Gravelly Wet Low Scrub
							Moist Graminoid	Bluejoint	Lowland Moist Meadow
							Needleleaf and Dwarf Tree	White Spruce Black-White Spruce Black Spruce Black Spruce-Tamarack	Lowland Wet Needleleaf Forest
							Mixed Forest	Spruce-Paper Birch	Lowland Wet Mixed Forest
							Broadleaf Forest	Paper Birch	Lowland Wet Broadleaf Forest
							Dwarf Tree	Mixed Conifer Woodland	Lowland Wet Low Scrub

Table 7 (cont'd).

Physiography	Soil texture	Geomorphology	Slope position	Drainage	Soil Subgroup	Permafrost	Common Vegetation Structure		Ecotype
							Structure (Level II)	Composition (Level IV)	
Lowland (cont.)	Fine/Organic	(cont.)	Flat	Poor	(cont.)	Present	Tall Scrub	Alder-Willow Broadleaf Scrub Woodland	Lowland Wet Tall Scrub
							Low Scrub	Shrub Birch-Ericaceous Shrub Mixed Shrub-Tussock Graminoid	Lowland Wet Low Scrub Lowland Tussock Bog
							Wet Graminoid	Sub. Lowland Sedge Wet Meadow	Lowland Wet Meadow
								Barren (Human Modified)	Human Modified
							Wet Forb	Lowland Herb Bog Meadow Fresh Herb Marsh	Lowland Fen Meadow
Lacustrine	Organic	Collapse Scar Fen Drainage Fen, Peat Margin Swamp Collapse Scar Bog Peat Plateau Bog Shore Fen	Flat	Flooded Poor Poor Poor Poor	Typic Cryofibrists Typic and Terric Cryofibrists Sphagnic-Cryoofibrists Terr. Fibrists Typic and Terric Cryofibrists	Absent Absent Absent Absent Absent	Tall Scrub	Tall Shrub Swamp	Lowland Scrub Fen
							Low Scrub	Willow-Graminoid Shrub Bog Sweetgale-Graminoid Bog	
							Wet Graminoid	Lowland Sedge Wet Meadow	Lowland Fen Meadow
							Wet Graminoid	Lowland Sedge-Moss Bog Meadow	Lowland Bog Meadow
							Broadleaf Forest	Paper Birch	Lowland Wet Broadleaf Forest
							Low Scrub	Willow-Graminoid Shrub Bog	Lowland Scrub Fen
							Wet Graminoid	Subarctic Lowland Wet Meadow Subarctic Lowland Subarctic Lowland Fresh Sedge Marsh	Lacustrine Fen Meadow Herb Bog Meadow Sedge Bog Meadow
							Water	Water	Lakes and Ponds
							Aquatic	Fresh Pondweed	
							Barren	Barren	Riverine Barrens
Riverine	Gravelly or Loamy	Meander or Braided Riverbed Meander or Braided Active-Floodplain Meandering, Braided, or Headwater Inactive Floodplain	Flat or Gentle Lower Slopes	Excess. Well Well Well Well Poor	Typic Cryofluent Cryofluent Typ. or Aqu. Cryofluents Typic Cryofluent Typic Cryofluent	Absent Absent Absent Absent Absent	Partially vegetated	Willow (Partially Vegetated)	
							Tall Scrub	Alder or Willow	Riverine Moist Tall Scrub
							Needleleaf Forest	White Spruce Black Spruce-White Spruce	Riverine Moist Needleleaf Forest
							Mixed Forest	White Spruce-Paper Birch White Spruce-Balsam Poplar	Riverine Moist Mixed Fores
							Broadleaf Forest	Balsam Poplar Paper Birch	Riverine Moist Broadleaf Forest
							Tall Scrub	Alder or Willow	Riverine Moist Tall Scrub
							Low Scrub	Willow-Graminoid Shrub Bog	Riverine Wet Low Scrub
							Wet Graminoid	Subarctic Lowland Sedge Wet Meadow, Fresh Sedge Marsh	Riverine Wet Meadow
							Barren	Barren (Human Modified)	Human Modified
								Water	Lower Perennial River
								Water	Lakes and Ponds

These vegetation types generally are associated because they occur along a successional sequence. For example, low scrub, tall scrub, broadleaf forest, mixed forest, and needleleaf forest is the typical successional sequence of vegetation development after fire (Foote 1983, Viereck et al. 1983).

The successive grouping of ecosystem components helps differentiate many forest types. For example, aspen generally was associated with upland areas and gravelly lowlands, balsam poplar generally was restricted to riverine areas, and tamarack generally occurred on lowland areas. Birch, white spruce, and black spruce, however, occurred over a wide range of conditions. For more detailed presentation of floristic differences among ecotypes, see the *Vegetation Composition* section.

A large question is how well these general relationships conform to the data set and thus can they be used reliably to extrapolate trends across the landscape. During development of the relationships, 17% (40/240) of the field observations were excluded from the table because of inconsistencies among physiography, texture, geomorphology, moisture, and vegetation. Some of the main inconsistencies, or departure from the central concepts, included frequent occurrence of moist sites (5/9) in Upland Wet Needleleaf Forest, frequent wet sites (3/9) in Riverine Moist Tall Scrub, frequent moist sites (12/50) in Lowland Wet Needleleaf Forest, and problems in differentiating lacustrine (associated with pond margins) from lowland physiography (4/15 sites). In addition, we often had difficulty in differentiating lowland from upland physiography related to small raised areas in the lowlands. Finally, we had to group thick (>40-cm) organic soils associated with flat bogs and veneer bogs with thinner organic deposits (grouped with loamy texture) associated with abandoned floodplain cover deposits. This was because organic depths frequently were near this cut point and because we could not differentiate the depths with aerial photography and surface observations.

The advantage of this hierarchical approach is that by combining physiography and vegetation structure, the resulting classes are relatively good at differentiating soil characteristics and vegetation composition. This approach is particularly useful for mapping, where the interpreter can easily distinguish physiography (e.g., flat lowlands vs. hilly uplands) and vegetation structure (e.g., needleleaf trees, broadleaf trees, shrubs, and graminoids), whereas distinguishing tree species (e.g., birch vs. poplar) or shrub species (e.g., dwarf

birch vs. willow) is difficult. Another advantage is that it links vegetation with soil characteristics. This linkage is particularly important for differentiating ecotypes that may have different sensitivities to disturbance. For example, Lowland Wet Broadleaf Forest (dominated by paper birch) were almost always associated with ice-rich permafrost and thus are susceptible to thermokarst that can lead to irreversible development of entirely different ecosystems after disturbance. In contrast, Upland Moist Broadleaf Forest (also dominated by birch) almost always was associated with well-drained, thaw stable soils and generally can recover to similar ecological conditions in a few decades after disturbance.

The main disadvantage to this approach is that physiography or slope position is scale dependent (e.g., a small raised area seen on the ground may function as an upland even though it occurs within a broad lowland area) and this contributes to uncertainty in classification and mapping. This problem with differentiation of physiography is similar to that associated with the hydrogeomorphic classes (e.g., slopes, depressions, flats) developed by Brinson (1993). A second disadvantage is that the grouping of the many ecological components can lead to generation of a large number of classes. For practical purposes, the number of classes needs to be reduced by combining similar characteristics and ignoring unusual plots that do not fit the simplified trends.

During the development of generalized trends that ignored unusual situations, our perspective was that it is better to preserve distinct, general trends, rather than include all the exceptions that violate the trends and thus increase confusion among classes. We believe that there is a limit to how well patterns on the landscape can be accounted for. Some proportion (in our case 17%) of sites cannot readily be explained, because they are transitional (ecotones) or have historical factors (e.g., change in water levels, disturbances) that may cause the ecosystem (particularly soils) to be in poor adjustment with current environmental conditions. The occurrence of these inconsistencies provides a theoretical upper limit for the accuracy of mapping of about 80–85%, because a certain portion of the landscape will not fit readily into any of the classes.

#### *Ecosystems and landscapes*

*Ecotypes.* The final classification of ecotypes (local ecosystems) included 41 individual classes,



Table 8. Description of ecotypes found on Ft. Wainwright, central Alaska, 1998.

Class	Description
Alpine Rocky Dry Dwarf Scrub	Alpine areas above treeline with dry, rocky soils and dwarf scrub vegetation. The soils are well-drained, have thin organic horizons, and frequently have rocks at the surface, are strongly acidic, and are associated with weathered bed rock. Permafrost status is uncertain. Vegetation is dominated by dwarf shrubs (mostly <i>Dryas octopetala</i> , with some <i>Salix arctica</i> , <i>Arctostaphylos alpina</i> ). Associated species include sedges ( <i>Carex bigelowii</i> ), numerous forbs, and lichens ( <i>Cladina</i> spp.).
Alpine Rocky Moist Tall and Low Scrub	Alpine areas near treeline with moist, rocky soils and vegetation dominated by low and tall shrubs. Soils have thin to moderately thick organic horizons, are excessively to well-drained, are strongly acidic, and are associated with weathered bedrock. Permafrost status is uncertain. Vegetation is dominated by shrubs ( <i>Betula nana</i> , <i>Salix planifolia</i> , <i>Ledum decumbens</i> , <i>Vaccinium uliginosum</i> , <i>V. vitis-idaea</i> ), sedges ( <i>Carex bigelowii</i> ), and mosses ( <i>Hylocomium splendens</i> , <i>Aulacomnium turgidum</i> ). Scattered <i>Picea glauca</i> (white spruce), <i>P. mariana</i> (black spruce), and <i>Betula papyrifera</i> (paper birch) often are present.
Upland Wet Needleleaf Forest	Upland areas on north-facing (and some east and west) slopes with variably wet and moist, rocky and loamy soils, and vegetation dominated by needleleaf trees. Soils vary from well- to poorly drained, have moderately thick to thick organic horizons, are strongly acidic, and are associated with residual soils, upland retransported deposits, and upland loess. Permafrost usually is present on steeper, north-facing slopes. Vegetation is dominated by <i>Picea mariana</i> , ericaceous shrubs ( <i>Ledum groenlandicum</i> , <i>Vaccinium uliginosum</i> , <i>V. vitis-idaea</i> , <i>Empetrum nigrum</i> ), and mosses ( <i>Hylocomium splendens</i> , <i>Sphagnum</i> spp.).
Upland Moist Needleleaf Forest	Upland, south-facing areas with moist, rocky to loamy soils and vegetation dominated by needleleaf trees. Soils are well-drained, have thin organic horizons, are strongly acidic, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. The late-successional vegetation is dominated by both <i>Picea glauca</i> (white spruce) and <i>P. mariana</i> (black spruce), <i>Alnus crispa</i> (green alder), ericaceous shrubs, and feather mosses ( <i>Hylocomium splendens</i> , <i>Pleurozium schreberi</i> ).
Upland Moist Mixed Forest	Upland, non-south-facing areas with moist, rocky to loamy soils and vegetation dominated by needleleaf and broadleaf trees. Soils are well-drained, have thin organic horizons, are moderately acidic, and lack permafrost. The mid-successional vegetation is dominated by a closed canopy of <i>Picea glauca</i> , <i>P. mariana</i> , and <i>Betula papyrifera</i> . The understory has <i>Alnus crispa</i> , <i>Vaccinium vitis-idaea</i> (lingonberry), <i>Cornus canadensis</i> (bunchberry), <i>Calamagrostis canadensis</i> (bluejoint reedgrass), and feather mosses.
Upland Moist Mixed Forest (south-facing)	Upland, south-facing areas with moist, rocky to loamy soils and vegetation dominated by needleleaf and broadleaf trees. Soils are well-drained, have thin organic horizons, are moderately acidic, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. The mid-successional vegetation is dominated by a closed canopy of <i>Picea glauca</i> , <i>P. mariana</i> , <i>Betula papyrifera</i> , and <i>Populus tremuloides</i> (quaking aspen), with <i>Shepherdia canadensis</i> (soapberry), <i>Viburnum edule</i> (high bushcranberry), <i>Linnaea borealis</i> (twin-flower), and feather mosses in the understory.
Upland Moist Broadleaf Forest	Upland areas on north-, east-, and west-facing slopes with moist, rocky to loamy soils and vegetation dominated by broadleaf trees. Soils are well-drained, have thin organic horizons, are strongly acidic, lack permafrost, are associated with residual soils, upland retransported deposits, and upland loess. This mid-successional forest has an open to closed canopy of <i>Betula papyrifera</i> and an understory of <i>Alnus crispa</i> , <i>Rosa acicularis</i> (prickly rose), <i>Cornus canadensis</i> , <i>Calamagrostis canadensis</i> , and feather mosses.
Upland Moist Broadleaf Forest (south-facing)	Upland areas on warm south-facing slopes with moist, rocky to loamy soils and vegetation dominated by broadleaf trees. Soils are well-drained, have thin organic horizons, are strongly acidic, and lack permafrost. This mid-successional stage after fire has an open to closed overstory of <i>Populus tremuloides</i> and <i>Betula papyrifera</i> . The understory includes <i>Picea glauca</i> , <i>Rosa acicularis</i> , <i>Shepherdia canadensis</i> , <i>Cornus canadensis</i> , <i>Linnaea borealis</i> , <i>Calamagrostis canadensis</i> , and feather mosses.
Upland Moist Tall Scrub	Upland areas with moist, rocky to loamy soils and vegetation dominated by tall shrubs. Soils are well-drained, have very thin organic horizons, are strongly acidic, lack permafrost, and are associated with residual soils, upland retransported deposits, and upland loess. This early successional stage after disturbance is dominated by dense thickets of <i>Alnus crispa</i> or <i>Salix</i> spp. and abundant leaf litter. Other common plants include <i>Calamagrostis canadensis</i> , <i>Epilobium angustifolium</i> (fireweed), and the moss <i>Polytrichum juniperinum</i> .
Upland Moist Low Scrub	Upland areas with moist, rocky to loamy soils and vegetation dominated by low shrubs and herbaceous plants. Soils are well-drained, have thin organic horizons, and lack permafrost. This early successional stage after fire is dominated by shrubs ( <i>Salix</i> spp., <i>Vaccinium uliginosum</i> , <i>Ledum groenlandicum</i> ), <i>Calamagrostis canadensis</i> , <i>Epilobium angustifolium</i> , and mosses ( <i>Polytrichum juniperinum</i> , <i>Ceratodon purpureus</i> ).

Table 8 (cont.). Description of ecotypes found on Ft. Wainwright, central Alaska, 1998.

Class	Description
Upland Rocky Dry Meadow	Upland areas on steep, south-facing slopes with dry, rocky soils and vegetation dominated by herbs. Soils are excessively drained, and lack organic horizons and permafrost. These sites are too dry to support trees so vegetation is dominated by scattered shrubs ( <i>Artemisia frigida</i> , <i>Juniperus communis</i> , <i>Rosa acicularis</i> ), grasses ( <i>Elymus innovatus</i> , <i>Festuca</i> spp.), and forbs ( <i>Galium boreale</i> , <i>Pulsatilla patens</i> , <i>Cnidium cnidifolium</i> ).
Upland Slope Drainage Complex	A complex mosaic of ecotypes associated with fluvial processes on upland areas. Closely repeating drainages produce an alternating pattern that includes Upland Moist Needleleaf Forest, Upland Moist Broadleaf Forest, and Upland Moist Tall Scrub.
Lowland Gravelly Moist Needle-leaf Forest	Lowland areas with moist, gravelly soils and vegetation dominated by needleleaf trees. Soils are somewhat well- to somewhat-poorly drained, have thin to moderately thick organic horizons, probably lack permafrost, and are associated with gravelly abandoned floodplains, alluvial fan deposits, and glaciofluvial deposits. Vegetation is dominated by an open canopy of <i>Picea mariana</i> , <i>Larix laricina</i> , and occasionally <i>P. glauca</i> . The understory commonly contains ericaceous shrubs ( <i>Ledum groenlandicum</i> , <i>Vaccinium uliginosum</i> , <i>V. vitis-idaea</i> ), <i>Potentilla fruticosa</i> (shrubby cinquefoil), and <i>Hylocomium splendens</i> .
Lowland Gravelly Moist Mixed Forest	Lowland areas on abandoned floodplains with moist, gravelly soils and vegetation dominated by needleleaf and broad leaf trees. Soils are well- to somewhat poorly drained, have thin to moderately thick organic horizons, are slightly acidic, and probably lack permafrost. The open to closed canopy is dominated by <i>Picea glauca</i> , <i>P. mariana</i> , <i>Larix laricina</i> , <i>Betula papyrifera</i> , and <i>Populus tremuloides</i> . The understory usually has <i>Alnus tenuifolia</i> , <i>Ledum groenlandicum</i> , <i>Vaccinium vitis-idaea</i> , <i>Rosa acicularis</i> , <i>Festuca</i> sp., and lichens.
Lowland Gravelly Moist Broadleaf Forest	Lowland areas with moist, gravelly soil and vegetation dominated by broadleaf trees. Soils are well-drained, have thin to moderately thick organic horizons, and probably lack permafrost. The open to closed forest canopy is dominated by <i>Betula papyrifera</i> , and/or <i>Populus tremuloides</i> . There is little data describing this type.
Lowland Gravelly Wet Tall Scrub	Lowland areas with wet, gravelly soils and vegetation dominated by tall shrubs. Soils are somewhat poorly drained, have thin organic horizons, lack permafrost, and are associated with gravelly abandoned river channels and cover deposits. The open or closed shrub canopy is dominated by <i>Alnus tenuifolia</i> , <i>Salix bebbiana</i> , and <i>S. planifolia</i> , with <i>Calamagrostis canadensis</i> in the understory.
Lowland Gravelly Wet Low Scrub	Lowland areas with wet, gravelly soils and vegetation dominated by low shrubs. Soils are poorly drained, have moderately thick organic horizons, and lack permafrost. The open or closed shrub canopy is dominated by <i>Betula nana</i> (shrub birch), <i>Salix planifolia</i> , and ericaceous shrubs. Scattered trees ( <i>Picea mariana</i> , <i>Larix laricina</i> ) often are present. Other common plants include <i>Myrica gale</i> (sweetgale) and <i>Potentilla fruticosa</i> .
Lowland Wet Needleleaf Forest	Lowland areas with wet, loamy to organic soils, and vegetation dominated by needleleaf trees. Soils are poorly drained, have moderate to thick organic horizons, are slightly acidic, usually have permafrost, and are associated with abandoned floodplain cover deposits, lowland retransported deposits on lower slopes, lowland loess, and flat bogs. The open to closed canopy is dominated by <i>Picea mariana</i> , although <i>P. glauca</i> and <i>Larix laricina</i> occasionally occur. The understory includes <i>Ledum groenlandicum</i> , <i>Vaccinium uliginosum</i> , <i>V. vitis-idaea</i> , <i>Hylocomium splendens</i> , and often <i>Sphagnum</i> spp.
Lowland Wet Mixed Forest	Lowland areas with wet, loamy to organic soils and vegetation with needleleaf and broadleaf trees. Soils are somewhat poorly drained, have moderately thick organic horizons, are neutral (pH), and are underlain by permafrost. The open to closed overstory is dominated by <i>Picea glauca</i> and <i>Betula papyrifera</i> , although <i>Populus tremuloides</i> and <i>P. mariana</i> are sometimes present. Understory plants include <i>Ledum groenlandicum</i> , <i>Calamagrostis canadensis</i> , <i>Vaccinium vitis-idaea</i> , and <i>Hylocomium splendens</i> .
Lowland Wet Broadleaf Forest	Lowland areas with wet, loamy to organic soils dominated by broadleaf trees. Soils are somewhat poorly drained, have moderately thick to very thick organic horizons, are moderately acidic, and are underlain by ice-rich permafrost. The usually closed overstory is dominated by <i>Betula papyrifera</i> , although <i>Picea glauca</i> and <i>P. mariana</i> are often present in the understory. Other plants include <i>Rosa acicularis</i> , <i>Calamagrostis canadensis</i> , and <i>Equisetum arvense</i> .
Lowland Wet Tall Scrub	Lowland areas with wet, loamy to organic soils and vegetation dominated by tall shrubs. Soils are poorly drained, have moderately thick to thick organic horizons, and are underlain by permafrost. The open to closed canopy of tall shrubs includes <i>Alnus tenuifolia</i> , <i>A. crispa</i> and <i>Salix bebbiana</i> ; <i>Betula papyrifera</i> and <i>Larix laricina</i> may be present. In the under story <i>Salix planifolia</i> , <i>Calamagrostis canadensis</i> , and <i>Equisetum arvense</i> are common.
Lowland Wet Low Scrub	Lowland areas with wet, loamy to organic soils and vegetation dominated by low shrubs. Soils are poorly drained, have thin to thick organic horizons, are moderately acidic, and are underlain by permafrost. The open to closed canopy of low shrubs is dominated by <i>Betula nana</i> and ericaceous shrubs ( <i>Ledum groenlandicum</i> , <i>Vaccinium uliginosum</i> , <i>V. vitis-idaea</i> ), although scattered trees ( <i>Picea mariana</i> , <i>Larix laricina</i> ) often are present. Other plants include <i>Calamagrostis canadensis</i> , <i>Chamaedaphne calyculata</i> , and <i>Sphagnum</i> mosses.

Table 8 (cont.).

Class	Description
Lowland Tussock Bog	Lowland areas with wet, loamy to organic soils and vegetation co-dominated by low shrubs and tussock-forming sedges. Soils are poorly drained, have thin to thick organic horizons, are moderately acidic, underlain by permafrost, and are associated with flat bogs or occasionally, lacustrine deposits. The open (25–75%) shrub canopy of <i>Betula nana</i> and ericaceous shrubs is punctuated by abundant <i>Eriophorum vaginatum</i> tussocks. Scattered <i>Picea mariana</i> and <i>Larix laricina</i> are common.
Lowland Moist Meadow	Lowland areas with moist, loamy soils and vegetation dominated by grasses. Soils are somewhat well-drained, have thin organic horizons, and lack permafrost. The sites occur in recently abandoned drainages and well drained thermokarst areas. <i>Calamagrostis canadensis</i> dominates these communities, although other graminoids, scattered shrubs (usually <i>Salix</i> spp.), and forbs may be present.
Lowland Scrub Fen	Lowland areas with wet, organic soils and vegetation dominated by shrubs. Soils are poorly drained, have very thick organic horizons, are minerotrophic, occasionally have permafrost, and are associated with abandoned floodplains, and drainage and shore fens. The open, low to tall canopy of shrubs is dominated by <i>Alnus tenuifolia</i> , <i>Salix planifolia</i> , <i>Chamaedaphne calyculata</i> , and <i>Myrica gale</i> . The understory has <i>Carex aquatilis</i> , <i>Calamagrostis canadensis</i> , <i>Potentilla palustris</i> , and <i>Sphagnum</i> spp.
Lowland Bog Meadow	Lowland areas with wet, organic soils and vegetation dominated by sedges and mosses. Soils are poorly drained, have thick organic horizons of <i>Sphagnum</i> and sedge peat, are strongly acidic, ombrotrophic, lack permafrost, and are associated with collapse-scar bogs. Vegetation is dominated by sedges ( <i>Carex aquatilis</i> , <i>Eriophorum russeolum</i> , <i>E. angustifolium</i> ) and <i>Sphagnum</i> spp., while <i>Calamagrostis canadensis</i> and <i>Oxycoccus microcarpus</i> are common associates.
Lowland Fen Meadow	Lowland areas with wet, organic soils and vegetation dominated by herbs. Soils have thick organic horizons of herbaceous peat, are neutral (pH), minerotrophic, lack permafrost, and are associated with collapse-scar fens. Vegetation is dominated by <i>Menyanthes trifoliata</i> , <i>Equisetum fluviatile</i> , <i>Carex rostrata</i> , and <i>Potentilla palustris</i> , while <i>C. aquatilis</i> , <i>Typha latifolia</i> , <i>Cicuta mackenzieana</i> , and <i>Galium trifidum</i> are common.
Lowland Eolian Complex	A mosaic of ecotypes on a wind-affected lowland landscape (i.e., loess, sand dunes, lowland retransported deposits, and organic collapse scar bogs). Common ecotypes include Lowland Wet Needleleaf Forest, Lowland Wet Broadleaf Forest, Lowland Wet Low Scrub, Lowland Moist Meadow, and Lowland Bog Meadow.
Lowland Slope Drainage Complex	A mosaic of ecotypes on a fluvially affected landscape (lowland eolian deposits, abandoned cover deposits, and lowland retransported deposits) characterized by numerous fluvial channels and water tracks. Ecotypes include Lowland Wet Needleleaf Forest, Lowland Wet Broadleaf Forest, Lowland Wet Low Shrub, and Lowland Wet Tall Scrub.
Lowland Abandoned Channel Complex	A mosaic of ecotypes on a fluvially affected landscape primarily associated with gravelly abandoned floodplains. Ecotypes include Lowland Gravelly Wet Needleleaf Forest, Lowland Gravelly Wet Broadleaf Forest, Lowland Gravelly Wet Low Scrub, and Lowland Scrub Fen.
Lowland Forest-Thermokarst Complex	A mosaic of ecotypes on a thermokarst-affected landscape associated with abandoned floodplains and collapse scar bogs dominated by forest and bog vegetation. Common ecotypes include Lowland Wet Broadleaf Forest, Lowland Wet Needleleaf Forest, and Lowland Bog Meadow.
Lowland Scrub-Thermokarst Complex	A mosaic of ecotypes on a thermokarst-affected landscape associated with abandoned floodplains and collapse scar features dominated by scrub and fen vegetation. Common ecotypes include Lowland Wet Tall Scrub, Lowland Wet Broadleaf Forest, Lowland Scrub Fen, and Lowland Fen Meadow.
Riverine Moist Needleleaf Forest	Riverine areas with moist, loamy soils and vegetation dominated by needleleaf trees. The well-drained soils have moderately thick organic horizons at the surface (indicative of very infrequent flooding), are strongly acidic, lack permafrost, and have deep water tables. Vegetation is dominated by an open or closed canopy of mature <i>Picea glauca</i> , although <i>P. mariana</i> and <i>Larix laricina</i> occasionally are present. Understory plants include <i>Alnus tenuifolia</i> , <i>Rosa acicularis</i> , <i>Cornus canadensis</i> , <i>Equisetum arvense</i> , <i>Hylocomium splendens</i> , and <i>Rhytidiadelphus triquetrus</i> .
Riverine Moist Mixed Forest	Riverine areas with moist, loamy soils and vegetation dominated by needleleaf and broadleaf trees. The well-drained soils have thin organic horizons interbedded with loamy sediment (indicating infrequent flooding), are moderately acidic, lack permafrost, and have deep water tables. The mid-successional forest has a closed canopy of <i>Picea glauca</i> – <i>Populus balsamifera</i> , though <i>P. glauca</i> – <i>Betula papyrifera</i> stands also occur. The understory is a mixture of species found in broadleaf and needleleaf riverine forests.
Riverine Moist Broadleaf Forest	Riverine areas with moist, loamy soils and vegetation dominated by broadleaf trees. The well-drained soils have thin organic horizons interbedded with loamy sediment (indicating infrequent flooding), are moderately acidic, lack permafrost, and have deep water tables. This early or mid-successional stage has an open or closed canopy of <i>Populus balsamifera</i> , although <i>Betula papyrifera</i> and <i>Populus tremuloides</i> occasionally are dominant. The understory has <i>Rosa acicularis</i> , <i>Calamagrostis canadensis</i> , and <i>Equisetum arvense</i> .

Table 8 (cont.). Description of ecotypes found on Ft. Wainwright, central Alaska, 1998.

Class	Description
Riverine Moist Tall Scrub	Riverine areas with moist, loamy soils and vegetation dominated by tall shrubs. The well-drained soils usually lack organic horizons (indicating frequent flooding), are slightly acidic, lack permafrost, and have moderately deep water tables. The closed canopy is dominated by willows ( <i>Salix arbusculoides</i> , <i>S. alaxensis</i> , <i>S. bebbiana</i> , <i>S. lasiandra</i> ) or <i>Alnus tenuifolia</i> . <i>Calamagrostis canadensis</i> , and <i>Equisetum arvense</i> also are common.
Riverine Wet Low Scrub	Riverine areas with wet, loamy soils and vegetation dominated by low shrubs. The poorly drained soils occur along channels near slow moving rivers and headwater streams. The vegetation is dominated by willows ( <i>Salix planifolia</i> ), ericaceous shrubs ( <i>Ledum groenlandicum</i> , <i>Vaccinium uliginosum</i> ) and sedges.
Riverine Wet Meadow	Riverine areas with wet, loamy soils and vegetation dominated by sedges. Soils are poorly drained, have ground water near the surface, usually lack organic horizons (indicating frequent flooding), lack permafrost, and are associated with abandoned channels and oxbows. Vegetation is dominated by <i>Carex aquatilis</i> and <i>C. rostrata</i> . Riverine Marshes, also included in this class, are dominated by <i>Scirpus validus</i> , <i>Equisetum fluviatile</i> and <i>Typha latifolia</i> .
Riverine Barrens	Unvegetated or partially vegetated (<30% cover) river bars that are flooded frequently. Colonizing species include <i>Salix alaxensis</i> , <i>S. interior</i> , and <i>Equisetum arvense</i> .
Riverine Complex	A mosaic of ecotypes associated with fluvial processes (river, active and inactive floodplains). Common ecotypes include Riverine Moist Needleleaf Forest, Riverine Moist Broadleaf Forest, Riverine Moist Tall Scrub, Riverine Wet Low Scrub, Riverine Wet Meadows, and Riverine Barrens.
Lacustrine Fen Meadow	These types are most commonly found on wet, organic soils at the borders of ponds and lakes, vegetation is dominated by herbs. Soils have moderate to thick organic horizons of herbaceous peat, are neutral (pH), minerotrophic, and lack permafrost. Vegetation is dominated by <i>Potentilla palustris</i> , <i>Equisetum fluviatile</i> , and <i>Carex aquatilis</i> . Associated species include <i>Menyanthes trifoliata</i> , <i>C. rostrata</i> , <i>Eriophorum russeolum</i> and <i>C. canescens</i> .
Lakes and Ponds	Lacustrine water bodies with or without submerged or floating vegetation (e.g. <i>Potamogeton</i> spp., <i>Nuphar polysepalum</i> , <i>Lemna minor</i> , or <i>Hippuris vulgaris</i> ). Lakes may be oxbows along rivers, bedrock controlled, or thaw basins.
Lower/Upper Perennial River	Lower perennial rivers, both braided and meandering, that are relatively far from their sources. Peak flooding generally occurs during spring breakup when ice jams, or in summer after heavy rainfall or rapid glacial melting. Some water flows throughout the year. Upper perennial rivers generally are small streams.
Human Modified	Barren or partially vegetated (<30% cover) areas resulting from human disturbance.

and an additional 6 complex units that were combinations of ecotypes occurring in highly patchy areas (Table 8). This final grouping of ecotypes was derived from 409 integrated terrain units (geomorphic-vegetation combinations) (see App. A). Much of this reduction and simplification resulted from combining geomorphic types that had similar texture and combining similar vegetation types that had small differences in canopy cover (open vs. closed) (see Table 3).

The maps reveal large differences in the distribution of ecotypes between the YMA and the Tanana Flats (Table 9, Fig. 23 and 24). The Yukon Maneuver Area was dominated by Upland Moist Needleleaf Forest, Upland Wet Needleleaf Forest, Upland Moist Broadleaf Forest, Upland Moist Mixed Forest, and Lowland Wet Needleleaf Forest. The YMA also had a few scattered patches of Alpine Rocky Dry Dwarf Scrub and Alpine Rocky Moist Tall and Low Scrub that were not found on the Tanana Flats. In contrast, the Tanana Flats was

dominated by Lowland Wet Needleleaf Forest, Lowland Wet Low Scrub, Lowland Fen Meadow, and Thermokarst Forest and Scrub Complexes that were not found in the YMA. The Tanana Flats also differed in that ecotypes often were highly patchy, resulting in the mapping of extensive complex units. One common forest ecotype, Lowland Wet Needleleaf Forest (dominated by Black Spruce) was the dominant component of the Lowland Forest-Thermokarst Complex.

*Ecosections.* Although separate ecosection maps have not been included in this report to reduce the volume and redundancy of material, they are essentially the same as the geomorphic maps because geomorphology is the differentiating characteristic (see *Geomorphology* section). The ecosection concept differs from a straight geomorphology map, however, in that conceptually the ecosection map is intended to include the ecotypes that generally are associated with each geomorphic unit (Table 7). For example, Weathered

**Table 9. Areal extent of ecotypes found within Ft. Wainwright, central Alaska, 1998 (Fig. 23 and 24).**

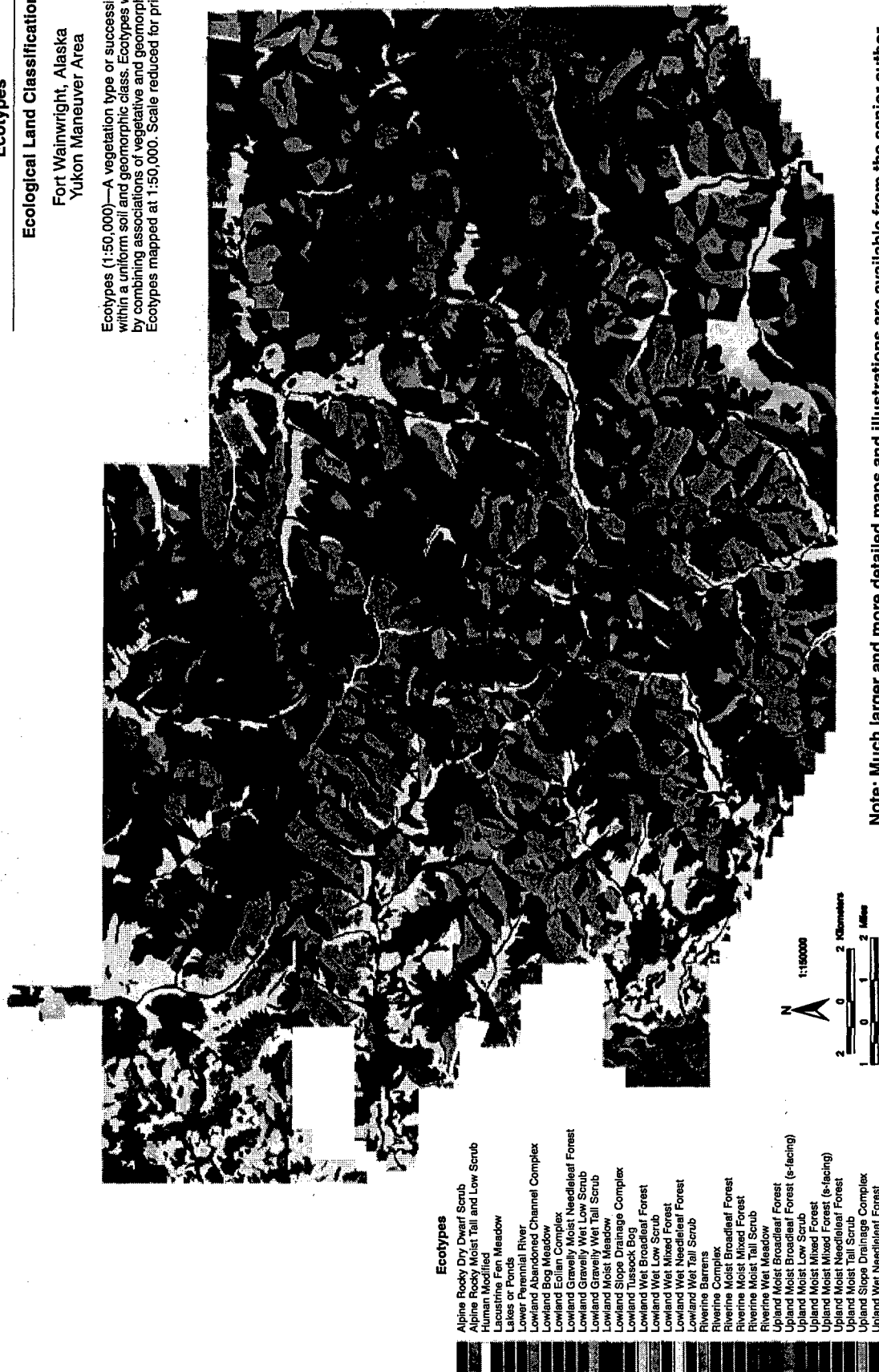
Ecotype class	Flats		YMA		Total	
	area (ha)	%	area (ha)	%	area (ha)	%
Alpine Rocky Dry Dwarf Scrub			45	0.0	45	0.0
Alpine Rocky Moist Tall and Low Scrub			1162	1.1	1162	0.3
Upland Moist Broadleaf Forest	1573	0.6	5192	5.0	6765	1.8
Upland Moist Broadleaf Forest (south-facing)	778	0.3	15,500	14.8	16,278	4.4
Upland Moist Low Scrub			855	0.8	855	0.2
Upland Moist Mixed Forest	2192	0.8	20,173	19.3	22,365	6.1
Upland Moist Mixed Forest (south-facing)	895	0.3	10,652	10.2	11,547	3.1
Upland Moist Needleleaf Forest	79	0.0	4861	4.7	4940	1.3
Upland Moist Tall Scrub			585	0.6	585	0.2
Upland Rocky Dry Meadow	91	0.0			91	0.0
Upland Slope Drainage Complex			2168	2.1	2168	0.6
Upland Wet Needleleaf Forest	136	0.1	14,777	14.1	14,913	4.0
Riverine Barrens	806	0.3	3	0.0	809	0.2
Riverine Complex	953	0.4	2461	2.4	3414	0.9
Riverine Moist Broadleaf Forest	3073	1.2	193	0.2	3266	0.9
Riverine Moist Mixed Forest	5061	1.9	95	0.1	5155	1.4
Riverine Moist Needleleaf Forest	6691	2.5			6691	1.8
Riverine Moist Tall Scrub	5209	2.0	1674	1.6	6883	1.9
Riverine Wet Low Scrub	544	0.2			544	0.1
Riverine Wet Meadow	840	0.3	15	0.0	855	0.2
Lowland Abandoned Channel Complex	7849	3.0	40	0.0	7889	2.1
Lowland Bog Meadow	224	0.1	19	0.0	243	0.1
Lowland Eolian Complex			2303	2.2	2303	0.6
Lowland Fen Meadow	10,408	3.9			10,408	2.8
Lowland Forest-Thermokarst Complex	30,934	11.7			30,934	8.4
Lowland Gravelly Moist Broadleaf Forest	366	0.1			366	0.1
Lowland Gravelly Moist Mixed Forest	2975	1.1			2975	0.8
Lowland Gravelly Moist Needleleaf Forest	2753	1.0	464	0.4	3217	0.9
Lowland Gravelly Wet Low Scrub	2805	1.1	265	0.3	3070	0.8
Lowland Gravelly Wet Tall Scrub	223	0.1	38	0.0	261	0.1
Lowland Moist Meadow	21	0.0	34	0.0	55	0.0
Lowland Scrub Fen	7297	2.8			7297	2.0
Lowland Scrub-Thermokarst Complex	39,203	14.9			39,203	10.6
Lowland Slope Drainage Complex	1878	0.7	2735	2.6	4612	1.3
Lowland Tussock Bog	7610	2.9	1890	1.8	9500	2.6
Lowland Wet Broadleaf Forest	1015	0.4	1144	1.1	2159	0.6
Lowland Wet Low Scrub	40,113	15.2	1963	1.9	42,076	11.4
Lowland Wet Mixed Forest	7547	2.9	1288	1.2	8835	2.4
Lowland Wet Needleleaf Forest	65,858	24.9	11,069	10.6	76,927	20.9
Lowland Wet Tall Scrub	2229	0.8	86	0.1	2315	0.6
Lacustrine Fen Meadow	891	0.3	106	0.1	997	0.3
Lakes or Ponds	650	0.2	80	0.1	730	0.2
Lower Perennial River	2152	0.8	39	0.0	2190	0.6
Human Modified	44	0.0	531	0.5	575	0.2
<i>Sum</i>	263,964	100.0	104,503	100.0	368,467	100.0

## Ecotypes

### Ecological Land Classification

Fort Wainwright, Alaska  
Yukon Maneuver Area

Ecotypes (1:50,000)—A vegetation type or successional stage within a uniform soil and geomorphic class. Ecotypes were created by combining associations of vegetative and geomorphic classes. Ecotypes mapped at 1:50,000. Scale reduced for printing.



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 23. Map of ecotypes within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.

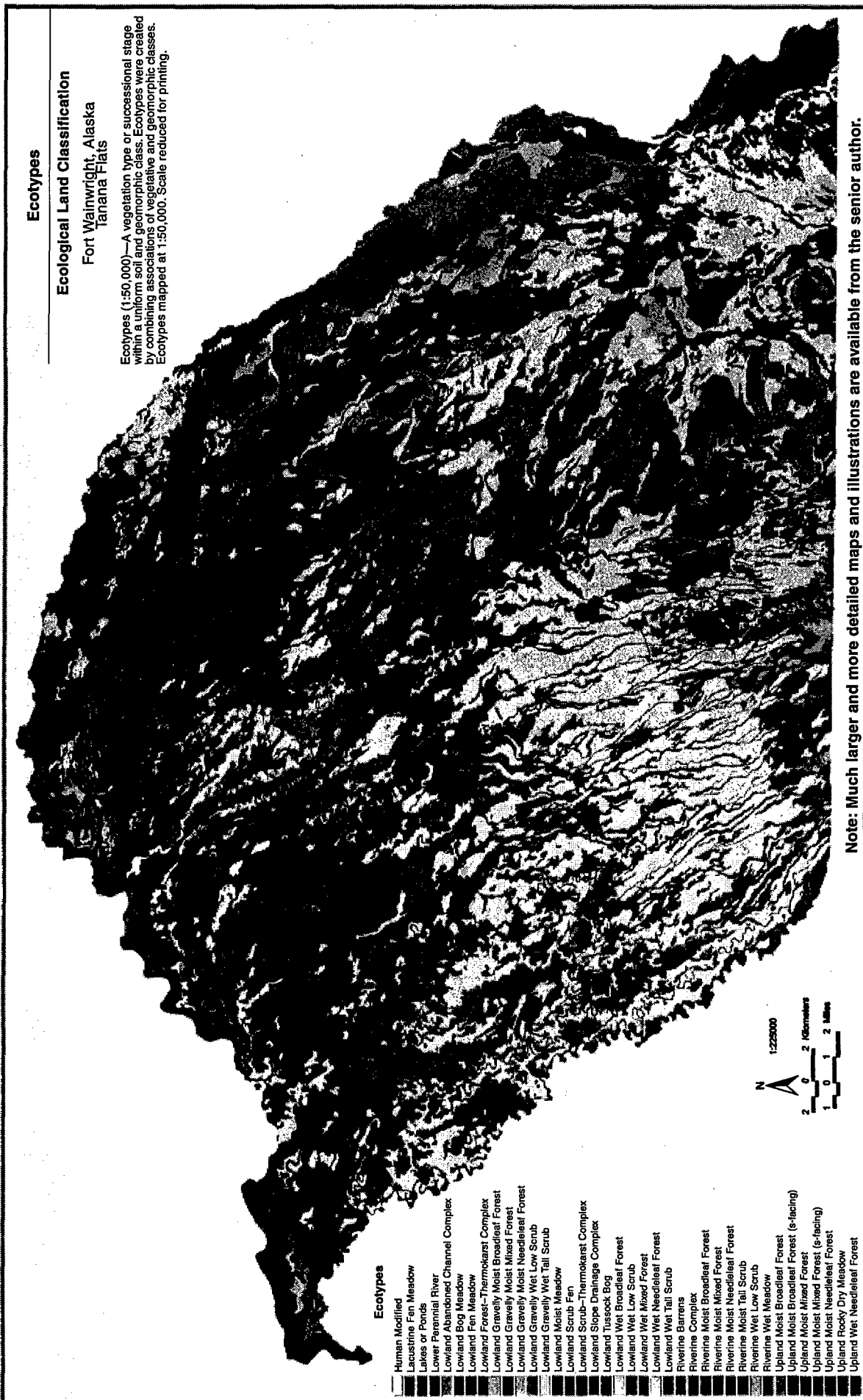


Figure 24. Map of ecotypes on the Tanana Flats, Ft. Wainwright, central Alaska, 1998.

**Table 10. Description of the physiography, geomorphology, hydrology, permafrost and vegetation of ecodistricts and ecosubdistricts mapped within Fort Wainwright, central Alaska, 1998 (Fig 25).**

<i>Ecodistrict</i>	<i>Ecosubdistrict</i>	<i>Description</i>
Tanana Floodplain	Eielson-Tanana Floodplain	A braided stretch of the Tanana River that includes braided-floodplain riverbed deposits, and active- and inactive floodplain cover deposits. The lower perennial glacial river is turbid with glacial silt. The area is subject to frequent flooding (every year on riverbed deposits), occasional flooding (every 2–5 years on active floodplain cover deposits) and infrequent flooding (about every 5–25 years on inactive floodplain cover deposits). Groundwater is near (<2–3 m) the surface and permafrost is absent. Vegetation includes partially vegetated river bars, riverine willow and alder tall scrub, and balsam poplar and white spruce forests. Forest productivity is high.
	Rosie Creek–Tanana Floodplain	A stretch of the Tanana Floodplain characterized by anastomosing channels, numerous stable islands and few braided river bars. Geomorphic units linked by fluvial processes include meander riverbed deposits, active and inactive cover deposits, and the lower perennial glacial river. Meander scrolls and backwater fens are common. The area has a similar flooding regime to that of the Eielson-Tanana Floodplain. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Chena Floodplain	A meandering stretch of the lower Chena River that includes meander riverbed deposits, and active- and inactive-floodplain cover deposits linked by surface and groundwater movement. The lower perennial river has clear water and a flooding regime similar to that of the Eielson-Tanana Floodplain. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Chena Slough Floodplain	A stretch of the Tanana floodplain that includes a large branch channel of the Tanana with numerous meander point bars. Geomorphology includes meander riverbed deposits, and active- and inactive-floodplain cover deposits linked by fluvial processes. The area has a similar flooding regime to that of the Eielson-Tanana Floodplain. Permafrost is absent. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Salchaket Slough Floodplain	A stretch of the Tanana floodplain that includes a large channel of the Tanana River. Geomorphology includes meander riverbed deposits, and active- and inactive-floodplain cover deposits linked by fluvial processes. The flooding regime is similar to that of the Eielson-Tanana Floodplain. Vegetation includes partially vegetated river barrens, riverine willow and alder tall scrub, balsam poplar and white spruce forests, and wet sedge meadows. Forest productivity is high.
	Fairbanks Lowlands	A flat area adjacent to the Tanana River that is dominated by abandoned-floodplain cover deposits and occasional organic bogs. Due to thick (1–2 m) cover deposits, there is little surface expression of the underlying fluvial morphology. The area is hydrologically linked to the Tanana Floodplain by groundwater movement and rare flooding events, but the lack of streams indicates little surface water movement. Permafrost is nearly continuous; it is absent in occasional collapse scar bogs caused by permafrost degradation. Common vegetation include black spruce, tamarack, and birch forests and shrub birch-ericaceous shrub.
	Eielson Lowland	A flat area adjacent to the Tanana River that is dominated by abandoned floodplain riverbed deposits with only thin cover deposits of overbank fines. Thermokarst features are rare and the surface is characterized by the braided pattern of the old riverbed. The area is hydrologically linked to the Tanana Floodplain by substantial groundwater movement and rare flooding events. Because of groundwater movement, permafrost is difficult to predict but probably sporadic. Vegetation is dominated by black spruce forest on interfluvies and shrub birch-ericaceous shrub and willow-sedge fens in abandoned channels.
	Salchaket Slough Lowlands	A flat area adjacent to the Tanana River dominated by thick abandoned floodplain cover deposits and occasional thermokarst features with organic bogs. The area is hydrologically linked to the Tanana River by groundwater movement and rare flooding events, but there is little surface water movement indicated by lack of streams. Permafrost is nearly continuous. Common vegetation types include black spruce, tamarack, and birch forests and shrub birch-ericaceous low scrub.
	Bear Creek Lowlands	An area adjacent to the Tanana River that is dominated by abandoned-floodplain riverbed deposits with only thin cover deposits of overbank fines. Thermokarst features are rare and the surface is characterized by the braided pattern of the old riverbed. The area is hydrologically linked to the Tanana Floodplain by substantial groundwater movement and rare flooding events. Due to groundwater movement permafrost is difficult to detect, but probably is sporadic. Vegetation is dominated by black spruce forests in interfluvies and shrub birch-ericaceous shrubs and willow-sedge fens in former channels.



Table 10 (cont'd).

<i>Ecodistrict</i>	<i>Ecosubdistrict</i>	<i>Description</i>
Tanana-Wood River Flats	Clear Creek Lowlands	A flat area dominated by abandoned floodplain cover deposits that have incorporated substantial amounts of lowland loess and organic deposits, as evident by the lack of fluvial patterning of the surface. Flat bogs are prevalent, but collapse-scar bogs are uncommon. The area is hydrologically linked to the Dry Creek Lowlands and has occasional seeps and small streams associated with subsurface water originating from Dry Creek. Permafrost is nearly continuous and ice-wedge polygons are evident in a few places. Vegetation is dominated by shrub birch-ericaceous low scrub, wet willow-sedge fens, and black spruce and tamarack forests.
	Willow Creek Lowlands	An area dominated by thick (3-4 m) abandoned-floodplain cover deposits and floating fens. Discontinuous, ice-rich permafrost is degrading rapidly and thermokarst features are abundant. Recently abandoned river channels are common and appear to be related to changes in water movement from surface streams to subsurface flow as floating fens increase in dominance. The area is a groundwater discharge zone linked to the Wood River Lowlands. Common vegetation includes birch forests, shrub swamps, floating fens, and collapse scar bogs, with occasional patches of black spruce forests and shrub birch-ericaceous low scrub.
	Crooked Creek Lowlands	An area dominated by thin (0.3-2 m) abandoned-floodplain cover deposits and meandering abandoned river channels. Collapse-scar bogs are abundant, as well as infilling old thaw lake basins. Floating fens are uncommon. The area receives much less groundwater from the Wood River Lowlands than does the Willow Creek Lowlands. Permafrost is discontinuous. Vegetation is dominated by black spruce and birch forests, shrub swamps, and sedge-moss bogs.
	Dry Creek Lowlands	An area dominated by alluvial fan deposits associated with Dry Creek; also present are riverbed deposits, cover deposits, and old dissected terraces associated with the Healy Glaciation. Dry Creek loses its water as it traverses the fan and disappears before it reaches the flats. Permafrost is nearly continuous. Vegetation is dominated by black spruce and birch forests, low and tall shrub (post-burn), shrub swamps and sedge-moss bogs.
	Wood River Lowlands	An area dominated by thick (1-2 m), fine-grained cover deposits on a glacial outwash fan associated with the Riley Creek Glaciation. Thermokarst features such as organic fens and bogs are common. There is both substantial surface and groundwater flow. Small streams form a dense network of nearly straight channels. Permafrost is discontinuous, but absent in bogs, fens and swamps. Vegetation is dominated by black spruce and birch forests, shrub-tussock meadows, shrub swamps and sedge-moss bogs.
Tanana-Wood River Flats	Little Delta River Lowlands	An area dominated by thick abandoned-floodplain cover deposits with few thermokarst features such as collapse scar bogs. There are occasional seeps and headwater streams. Permafrost is nearly continuous and fine-grained soils are usually saturated. Vegetation is dominated by black spruce and shrub-tussock meadows, with minor amounts of birch forest along well-drained uplands.
	Tanana-Blair Lake Uplands	The Wood River and Clear Creek Buttes and the hills near Blair Lakes are dominated by residual soils on upper slopes, upland retransported deposits on midslopes, and lowland retransported deposits on lower slopes. The units are hydrologically linked by surface and groundwater movement. Permafrost is present on northern and lower slopes and absent on southern slopes. The vegetation is dominated by white spruce-birch-aspen forests on upper slopes, black spruce and birch forests on lower slopes, and dry <i>Elymus</i> -shrub on steep south-facing bluffs.
	Wood River Uplands	An area dominated by well-drained abandoned riverbed deposits associated with a glacial outwash fan of the Riley Creek Glaciation. Surface streams are uncommon. Permafrost probably is absent and thermokarst features are not evident. The vegetation is dominated by white spruce-birch-aspen forests or by herbaceous and shrubby vegetation in burned areas.
Steese-White Mountains	Chena-Salcha Highlands	An association of weathered bedrock in alpine areas, residual soil on upper slopes, upland loess near the Tanana River, upland retransported deposits, lowland retransported deposits on lower slopes, and headwater streams. The areas are hydrologically linked by surface and groundwater flow. Permafrost is present on northern and lower slopes and absent on southern slopes. White spruce-birch-aspen forests on south slopes, black spruce forests on north slopes, riverine willows in drainages, and alpine tundra on high exposed ridges are common.
	Little Chena Uplands	Well-drained upland areas that have a loess cap over weathered bedrock. Permafrost is present on northern and lower slopes and absent on southern slopes. In permafrost-free areas, groundwater is found only at great depths, whereas in permafrost areas, the soil may be saturated for portions of the growing season white spruce-birch-aspen forests on south slopes, black spruce forests on north slopes, and riverine willows in small drainages are common.

**Table 10 (cont'd). Description of the physiography, geomorphology, hydrology, permafrost and vegetation of ecodistricts and ecosubdistricts mapped within Fort Wainwright, central Alaska, 1998.**

<i>Ecodistrict</i>	<i>Ecosubdistrict</i>	<i>Description</i>
Steese-White Mountains (cont'd.)	Stuart Creek Lowlands	An association of retransported deposits on lower slopes, meander riverbed deposits, and meander active and inactive floodplain cover deposits. Permafrost is continuous, except under larger streams. Vegetation is dominated by black spruce and birch forests, low shrubland and tussock tundra on fine-grained, saturated soils. White spruce-balsam poplar forests are found along floodplains.
	French-Moose Creek Lowlands	This area has been greatly affected by eolian deposition adjacent to the Tanana River. The low knob and swale topography has an association of lowland loess, eolian sand, lowland retransported deposits, and organic collapse scar and flat bogs. The area generally is above the Tanana Floodplain, but has numerous small streams originating in the highlands. Permafrost is nearly continuous; it is absent in collapse scar bogs, thaw ponds, and ridges of well-drained sand dunes. Black spruce and birch forests, shrub-tussock meadows, sedge-moss bogs, and aquatic vegetation in shallow thaw ponds are common.

Bedrock with an Alpine climate has repeating assemblages of Alpine Rocky Dry Dwarf Scrub and Alpine Rocky Moist Tall and Low Scrub, whereas Abandoned Floodplain Cover Deposits are dominated by Lowland Wet Needleleaf Forest, Lowland Wet Broadleaf Forest, and Lowland Wet Low Scrub. In addition, ecosection maps are produced at a smaller scale (typically 1:100,000 to 1:250,000) with larger minimum mapping size for patches; thus many tiny patches would be eliminated.

Viewing the geomorphic maps (Fig. 4 and 5) as if they were ecosection maps reveals a close association among groups of ecosections that are hydrologically linked by surface and groundwater movement. This water movement affects loss and accumulation of sediments and nutrients and, thus, greatly affects thermal status and ecosystem productivity. For example, in the White Mountain Ecodistrict, Weathered Bedrock ecosections on ridges, Residual Soil ecosections on upper slopes, Lowland Retransported ecosections on lower slopes, and Headwater Stream ecosections in valley bottoms all are linked by the downslope movement of water and sediments. The accumulation of fine-grained sediments and organic material and increased moisture in valley bottoms lead to thermal properties that are conducive to permafrost formation. In the Eielson-Tanana Floodplain Ecodistrict, ecosections on Riverbed, Active- and Inactive-Cover Deposits are linked by the flooding regime and sediment transport of the Tanana River. In the Tanana Flats Ecodistrict, ecosections on Abandoned Floodplain Cover Deposit, Alluvial Fan Abandoned Floodplain Cover Deposit, and Glaciofluvial Abandoned Floodplain Cover Deposit are all linked by hydrologic changes during deglaciation in the Holocene. Ecosections associated with organic depos-

its on the flats can occur on Veneer or Flat Bogs overlying the ice-rich Abandoned Floodplain Cover Deposits, or more recognizably, on Collapse Scar Bogs and Fens that result from paludification in pits and ponds as a result of thermal degradation of ice-rich permafrost.

*Ecodistricts.* Ecodistrict maps were created by a separate delineation on Landsat satellite imagery based on the recurring patterns of geomorphic classes with distinctive physiographic characteristics. Three ecodistricts and 21 ecosubdistricts were delineated within Fort Wainwright (Table 10, Fig. 25). Ecodistricts and ecosubdistricts both use geomorphology and physiography as the differentiating characteristics, but differ in that ecosubdistricts delineate smaller areas with less variation in the composition of the geomorphic assemblages.

The ecodistricts provide a way of stratifying the distribution of ecotypes that frequently are contextually related. For example, Lowland Fen Meadow, Lowland Scrub Fen, and Lowland Bog Meadow were found almost exclusively on the Tanana-Wood River Flats Ecodistrict because of the predominance of ice-rich, fine-grained soils. Similarly, riverine ecotypes were found predominantly in the Tanana Floodplain Ecodistrict because they are associated with flooding and sedimentation. Alpine ecotypes were limited in distribution to the Steese-White Mountain Ecodistrict because of the higher topographic relief.

This successive partitioning of the landscape is useful not only for field sampling, but improves the reliability of conceptual models of ecosystem distribution developed from toposequences. In turn, the ecodistricts are useful for land management, because management concerns and objectives will be different, depending on the predominant geomorphic and vegetation characteristics of the area.

# **Ecodistricts and Ecosubdistricts** **Ecological Land Classification** **Fort Wainwright, Alaska**

**ECODISTRICTS:** Major landforms or physiographic units within a climatic region that influence moisture availability and exposure to radiant solar energy. Bedrock geology is an important factor, while the range of geomorphic units that are included in ecodistricts is greater than those included in ecosubdistricts. Names for ecodistricts are based on prominent geographic features and broad physiographic landforms.

**ECOSUBDISTRICTS:** Smaller physiographic regions based on repeating associations of geomorphic units that are linked by erosional and deposition processes related to water movement (e.g., grouping of weathered bedrock on crest, residual soil on upper slopes, retransported deposits on lower slopes, and headwater streams in drainages). They have distinctive, repeating associations of vegetation, soils, permafrost distribution, waterbodies, and fauna.



**Note:** Much larger and more detailed maps and illustrations are available from the senior author.

*Figure 25. Map of ecodistricts within Ft. Wainwright, central Alaska, 1998.*

**Table 11. Mean cover (%) of the most abundant species within alpine and upland ecotypes at Ft. Wainwright, central Alaska, 1998. Blanks in table indicate a species was not present. 0 indicates cover <0.5%, and bolded values indicate frequency of occurrence is >60% within an ecotype.**

Species	Alpine Rocky Dry Dwarf Scrub	Alpine Rocky Moist Tall and Low Scrub	Upland Moist Needleleaf Forest	Upland Wet Needleleaf Forest	Upland Moist Mixed Forest	Upland Moist Mixed Forest (south-facing)	Upland Moist Tall Scrub	Upland Moist Broadleaf Forest	Upland Moist Broadleaf Forest (south-facing)	Upland Rocky Dry Meadow
<i>Dryas octopetala</i>	55									
<i>Lupinus arcticus</i>	5	0								
<i>Salix arctica</i>	3	1								
<i>Aster sibiricus</i>	1									
<i>Polygonon viviparum</i>	1									
<i>Tofieldia coccinea</i>	1									
<i>Salix phlebophylla</i>	1									
<i>Anemone narcissiflora</i>	1	0								
<i>Polygonon bistorta</i>	1	2								
<i>Artemisia tilesii</i>	1	0	0				0			
<i>Pedicularis labradorica</i>	1		0			2			0	
<i>Rhytidium rugosum</i>	5	3	0							
<i>Carex bigelowii</i>	10	14	1							
<i>Cladina</i> sp.	60	37	3		0	1	0		1	
<i>Betula nana</i>	15	38	10							
<i>Ledum decumbens</i>		12	2							
<i>Aulacomnium turgidum</i>		12	0							
<i>Salix planifolia-pulchra</i>		8	3	0			8			
<i>Petasites frigidus</i>	1	0					4			
<i>Sphagnum</i> sp.				13						
<i>Empetrum nigrum</i>	5	7	6	5		0			1	
<i>Vaccinium uliginosum</i>	5	17	8	5			3	0	0	
<i>Arctostaphylos rubra</i>		2	0	0		1	1		1	
<i>Peltigera aphthosa</i>		3	2	1	2	1	0		0	
<i>Picea mariana</i>		1	22	53	6	3	0	5	5	
<i>Vaccinium vitis-idaea</i>	5	5	15	10	11	12	1	0	3	
<i>Polytrichum</i> sp.	3	5	5	6	4	9	7	5	2	
<i>Picea glauca</i>	3	1	24	0	35	27	2	3	5	
<i>Hylocomium splendens</i>		18	47	52	16	22	4	8	7	
<i>Geocaulon lividum</i>			5	5	2	3			2	
<i>Ledum groenlandicum</i>			9	20	6		1	0	9	
<i>Cornus canadensis</i>			3	1	11	1	1	9	1	
<i>Pleurozium schreberi</i>			21	17	13	6	2	5	1	
<i>Alnus crispa</i>			5	3	23	1	58	15	16	
<i>Betula papyrifera</i>			2	3	44	10	4	69	32	
<i>Linnaea borealis</i>	1		0		1	13	1	1	8	
<i>Lycopodium annotinum</i>	1		0		4		1	2	1	
<i>Epilobium angustifolium</i>		1	0	0		1	6	1	1	
<i>Populus tremuloides</i>			1	1	1	37	1	0	31	
<i>Spiraea beauverdana</i>			0	1			5	0		
<i>Viburnum edule</i>			0		0	8		9	1	
<i>Mertensia paniculata</i>			0	0	0	4			1	1
<i>Dicranum</i> sp.		2	1	0	4	3	1	1	1	
<i>Calamagrostis canadensis</i>			1	1	13	1	20	20	5	
<i>Rosa acicularis</i>			0	0	9	4		11	2	14
<i>Shepherdia canadensis</i>			2			8			2	1
<i>Galium boreale</i>			0			1			1	5
<i>Delphinium glaucum</i>									0	3
<i>Elymus innovatus</i>										19
<i>Artemisia frigida</i>										3
<i>Pulsatilla patens</i>										3
<i>Arabis</i> sp.										2
<i>Erigeron glabellus</i>										3
<i>Erigeron pumilus</i>										2
<i>Minuartia obtusiloba</i>										2
Sample size	2	3	9	8	9	5	9	10	10	2

Recognition of ecosystem differences within these broad areas also helps to identify gaps where more information is needed for land management. For example, considerable research has been conducted within the Eielson-Tanana Floodplain as part of the Long-Term Ecological Research Program (Van Cleve et al. 1986, 1993) in recognition of the high productivity of ecosystems in this ecodistrict, whereas little is known about ecological processes on the Tanana Flats (Racine and Walters 1994). For land management purposes, then, more information may need to be collected on ecological processes in the other ecodistricts on Ft. Wainwright to address specific management priorities.

### Ecosystem characteristics

#### *Vegetation composition*

The following discussion highlights some of the similarities and differences in species composition among ecotypes. Ecotypes were grouped by physiography to facilitate comparisons (Tables 11–13).

Alpine ecotypes generally were dominated by shrubs (Table 11). Alpine Rock Dry Dwarf Shrub was dominated by *Dryas octopetala*, *Carex bigelowii*, *Betula nana*, *Arctostaphylos rubra*, and lichens, mostly *Cladina* spp. In contrast, Alpine Rocky Moist Tall and Low Scrub was dominated by *Betula nana*, *Ledum decumbens*, *Salix planifolia* ssp. *pulchra*, *Empetrum nigrum*, *Carex bigelowii*, and *Cladina* spp. Krummholz forms of *Picea glauca* and *P. mariana* at treeline intergraded into the latter ecotype.

Upland ecotypes varied from forest and shrub to graminoid-meadow dominated systems (Table 11). Upland Moist Needleleaf Forest was dominated by both *Picea glauca* and *P. mariana*, which were prevalent even on south-facing slopes on the rocky uplands of the YMA. Understory species were dominated by *Vaccinium vitis-idaea*, *Empetrum nigrum*, and the feathermoss *Hylocomium splendens*. Upland Wet Needleleaf Forest, which typically occurred on north-facing slopes with permafrost, was dominated by *P. mariana*, *Vaccinium vitis-idaea*, *Ledum groenlandicum*, *V. uliginosum*, and commonly had *Sphagnum* mosses. This ecotype was similar in composition to Lowland Wet Needleleaf Forest. Upland Moist Broadleaf Forest was dominated by *Betula papyrifera*, *Alnus crispa*, *Rosa acicularis*, *Viburnum edule*, and typically had *P. glauca* in the understory canopy. Upland Moist Broadleaf Forest (south facing) also had *Populus tremuloides*, *Linnaea borealis*, and

*Shepherdia canadensis*, which are good indicators of drier conditions. Upland Moist Mixed Forest was dominated by both *P. glauca* and *Betula papyrifera* in the overstory, whereas Upland Moist Mixed Forest (south facing) had more *Populus tremuloides*, *Linnaea borealis*, and *Shepherdia canadensis*. Upland Moist Tall Scrub is dominated by *Alnus crispa*, *Vaccinium uliginosum*, scattered *B. papyrifera*, and occasionally *S. planifolia* ssp. *pulchra* near treeline. Upland Rocky Dry Meadow, which occurs on steep, south-facing bluffs, was dominated by *Elymus innovatus*, *Artemisia frigida*, *Rosa acicularis*, and *Galium boreale*.

Lowland ecotypes had six classes that were dominated by trees (Table 12). Lowland Wet Needleleaf Forest was dominated by *Picea mariana*, *Ledum groenlandicum*, *Vaccinium vitis-idaea*, and *V. uliginosum*, and *Sphagnum* spp. occasionally was also present. Lowland Gravelly Moist Lowland Forest was similar, except *P. glauca* was more abundant and *Sphagnum* generally was lacking. Lowland Wet Broadleaf Forest was dominated by *Betula papyrifera*, *Calamagrostis canadensis*, *Alnus* spp., *Ledum groenlandicum*, and *Equisetum arvense* with *Picea* spp. was common in the understory canopy. Lowland Wet Mixed Forest was dominated by both *P. glauca* and *B. papyrifera* in the overstory, and *Vaccinium vitis-idaea*, *Calamagrostis canadensis*, and *Hylocomium splendens* in the understory. Lowland Gravelly Moist Mixed Forest was similar, except that *Populus tremuloides*, *Shepherdia canadensis*, and *Arctostaphylos uva-ursi* often were present, indicating drier conditions.

Lowland ecotypes had five classes dominated by shrubs, although scattered trees of *Picea mariana*, *Larix laricina*, and *Betula papyrifera* commonly were present (Table 12). Lowland Wet Tall Scrub was dominated by an open canopy of *Alnus tenuifolia* and *Salix bebbiana*, and included *S. planifolia* ssp. *pulchra*, *Calamagrostis canadensis*, and *Equisetum arvense*. Lowland Wet Low Scrub was dominated by an open to closed canopy of *Betula nana*, and included *Chamaedaphne calyculata*, *Calamagrostis canadensis*, *Sphagnum* spp., and numerous ericaceous shrubs. Lowland Gravelly Wet Low Scrub was similar, except *Ledum groenlandicum* was more abundant, *Sphagnum* spp. generally was absent, and *Potentilla fruticosa* frequently was present. Lowland Tussock Bog was dominated by *Eriophorum vaginatum*, *Betula nana*, *Ledum groenlandicum*, *Chamaedaphne calyculata*, *Calamagrostis canadensis*, and *Sphagnum* spp. Lowland Scrub Fen was dominated by *A. tenuifolia*, *S. planifolia* ssp. *pulchra*, *Carex aquatilis*, *Calamagrostis canadensis*,

Table 12. Mean cover (%) of the most abundant species within lowland ecotypes at Ft. Wainwright, central Alaska, 1998. Blanks in table indicate a species was not present, 0 indicates cover >0.5%, and bold values indicate frequency of occurrence is >60% within an ecotype.

Species	Lowland Fen Meadow	Lacustrine Fen Meadow	Lowland Bog Meadow	Lowland Moist Meadow	Lowland Scrub Fen	Lowland Wet Low Scrub	Lowland Tussock Bog	Lowland Wet Tall Scrub	Lowland Wet Mixed Forest	Lowland Wet Broadleaf Forest	Lowland Gravelly Wet Low Scrub	Lowland Wet Needleleaf Forest	Lowland Gravelly Moist Needleleaf Forest	Lowland Gravelly Moist Mixed Forest
<i>Typha latifolia</i>	6													
<i>Galium trifidum</i>	4	0												
<i>Cicuta mackenziana</i>	2				0									
<i>Menyanthes trifoliata</i>	24	11												
<i>Epilobium palustre</i>	0	0	0											
<i>Potentilla palustris</i>	12	12	3	2	5	2	0							
<i>Carex rostrata</i>	11	16		16	3	1		0						
<i>Carex aquatilis</i>	6	5	27		23	3								
<i>Equisetum fluviatile</i>	16	7	2		4	4				2			1	
<i>Carex canescens</i>	0	9	1		1	3								
<i>Eriophorum russeolum</i>		11	3			3								
<i>Eriophorum angustifolium</i>	1		3	2	4	2					1	0		
<i>Oxycoccus microcarpus</i>	0	0	1		0	0		1				1		
<i>Sphagnum</i> sp.	11	1	85	0	20	26	13	7	0	0	1	12	0	0
<i>Calamagrostis canadensis</i>		4	10	38	18	16	7	24	6	36	4	4	1	
<i>Alnus tenuifolia</i>	2				12	8	2	17	1	15	1	1	0	5
<i>Salix planifolia-pulchra</i>	0	0		0	10	8	3	7		2	5	1	1	
<i>Chamaedaphne calyculata</i>	0	4	0	0	6	11	4		0		1	1	0	
<i>Myrica gale</i>					7	0	3				4			
<i>Larix laricina</i>		1		0	1	5	2	2	0	1	5	6	5	5
<i>Betula nana</i>		0		0	2	24	12		9	2	41	4	1	
<i>Picea mariana</i>		1				4	2		3	1	7	43	38	3
<i>Eriophorum vaginatum</i>						8	46			1	1	3		
<i>Rubus chamaemorus</i>					1	4	6		2	1	2	3	1	
<i>Betula papyrifera</i>	2	1			5	1	3	7	15	56	1	2	4	5
<i>Vaccinium uliginosum</i>					1	7	6	5	3	1	14	6	8	3
<i>Ledum groenlandicum</i>		0	0		1	13	4	7	44	8	28	22	25	35
<i>Vaccinium vitis-idaea</i>		0			0	5	11	1	20	7	7	20	13	23
<i>Salix bebbiana</i>					1	0	0	15	2	0	1	1		
<i>Potentilla fruticosa</i>		4			1		0				8	1	4	5
<i>Equisetum arvense</i>					0		0	7	1	14	3	4	2	3
<i>Mertensia paniculata</i>						0		2	2	1		1	0	1
<i>Picea glauca</i>	2			0	1	1		1	30	4		10	23	15
<i>Hylocomium splendens</i>					2	2	1	7	40		3	36	51	11
<i>Salix glauca</i>				1		2	0		8	1	1	2	0	5
<i>Populus tremuloides</i>				0					4	2		1	2	4
<i>Rosa acicularis</i>					1			2	5	5	0	4	2	2
<i>Salix arbusculoides</i>					3	0	2	2	1	3		1	0	1
<i>Geocaulon lividum</i>						1		2	2			2	1	8
<i>Viburnum edule</i>									1	1		0		
<i>Epilobium angustifolium</i>					0	0	0	1		0	0	0		2
<i>Cornus canadensis</i>						0				3	1	1	0	1
<i>Polytrichum</i> sp.							2		1	1		2		6
<i>Arctostaphylos uva-ursi</i>									4					5
<i>Shepherdia canadensis</i>									5			1	0	1
<i>Empetrum nigrum</i>									2			2	0	3
<i>Arctostaphylos rubra</i>									0		1	2	1	1
<i>Linnaea borealis</i>												1	0	3
<i>Cladina</i> sp.											4	2	1	3
<i>Lycopodium annotinum</i>												1	3	1
Crustose lichen														25
<i>Festuca</i> sp.														10
Sample size	10	8	3	5	8	8	7	3	5	5	5	40	5	2

**Table 13. Mean cover (%) of the most abundant species within riverine ecotypes at Ft. Wainwright, central Alaska, 1998. Blanks in table indicate a species was not present, 0 indicates cover <0.5%, and bolded values indicate frequency of occurrence is >60% within an ecotype.**

Species	Riverine Moist Needleleaf Forest	Riverine Moist Mixed Forest	Riverine Moist Tall Scrub	Riverine Moist Broadleaf Forest	Riverine Wet Meadow
<i>Ptilium crista-castrensis</i>	5				
<i>Pleurozium schreberi</i>	9	3			
<i>Pyrola secunda</i>	2	3	0		
<i>Peltigera aphthosa</i>	1		0		
<i>Linnaea borealis</i>	15		1		
<i>Rhytidiadelphus triquetrus</i>	16		1	0	
<i>Alnus crispa</i>	5	30			
<i>Hylocomium splendens</i>	30	3	7		
<i>Geocaulon lividum</i>	4	1	1	1	
<i>Cornus canadensis</i>	27	15	7	2	
<i>Mertensia paniculata</i>	2		0	0	
<i>Viburnum edule</i>	6	8	0	1	
<i>Rosa acicularis</i>	13	20	6	41	
<i>Picea glauca</i>	43	15	3	9	
<i>Equisetum arvense</i>		5	14	18	
<i>Epilobium angustifolium</i>	0	6	0	1	
<i>Polytrichum sp.</i>		1	0		
<i>Calamagrostis canadensis</i>	2	21	16	31	1
<i>Alnus tenuifolia</i>	5	30	31	1	1
<i>Betula papyrifera</i>	3	15	1	29	
<i>Populus balsamifera</i>		10	1	35*	
<i>Salix bebbiana</i>	1		11	16	
<i>Salix arbusculoides</i>			14	0	0
<i>Vaccinium vitis-idaea</i>		5	5		
<i>Empetrum nigrum</i>		5	1		
<i>Galium boreale</i>		1	0	1	
<i>Salix alaxensis</i>			6		
<i>Rubus idaeus</i>			0	3	
<i>Carex rostrata</i>			1		38
<i>Potentilla palustris</i>			3		1
<i>Equisetum fluviatile</i>					10
Sample size	4	2	9	4	4

\*A common species, but encountered in only 2 of 4 plots.

and *Potentilla palustris*, with *Myrica gale* and *C. calyculata* often present.

Lowland ecotypes had four classes dominated by graminoids and forbs (Table 12). Lowland Fen Meadow was dominated by *Menyanthes trifoliata*, *Equisetum fluviatile*, and *Potentilla palustris*. Lacustrine Fen Meadow was similar, except *Eriophorum russeolum* was more common, as were the shrubs *Chamaedaphne calyculata* and *Potentilla fruticosa*. Lowland Bog Meadow was dominated by *Sphagnum* spp. and *Carex aquatilis*, and the dwarf shrub *Oxycoccus microcarpus* usually was present. Lowland Moist Meadow was dominated by *Calama-*

*grostis canadensis*, and *Carex rostrata* and *Carex aquatilis* occasionally were present.

A companion floristic survey on Ft. Wainwright performed by Racine et al. (1997) found 491 vascular plant species (including subspecies and varieties) and 215 species of ground-inhabiting cryptograms, including 95 mosses, 109 lichens, and 10 liverworts. The inventory found 11 species of rare vascular plants that are being tracked by the Alaska Natural Heritage Program, but none of these taxa are listed by the U.S. Fish and Wildlife Service as endangered or threatened. The large floristic diversity on Ft Wainwright reflects the large size of the study area and wide range of climatic, geomorphic, and hydrologic conditions.

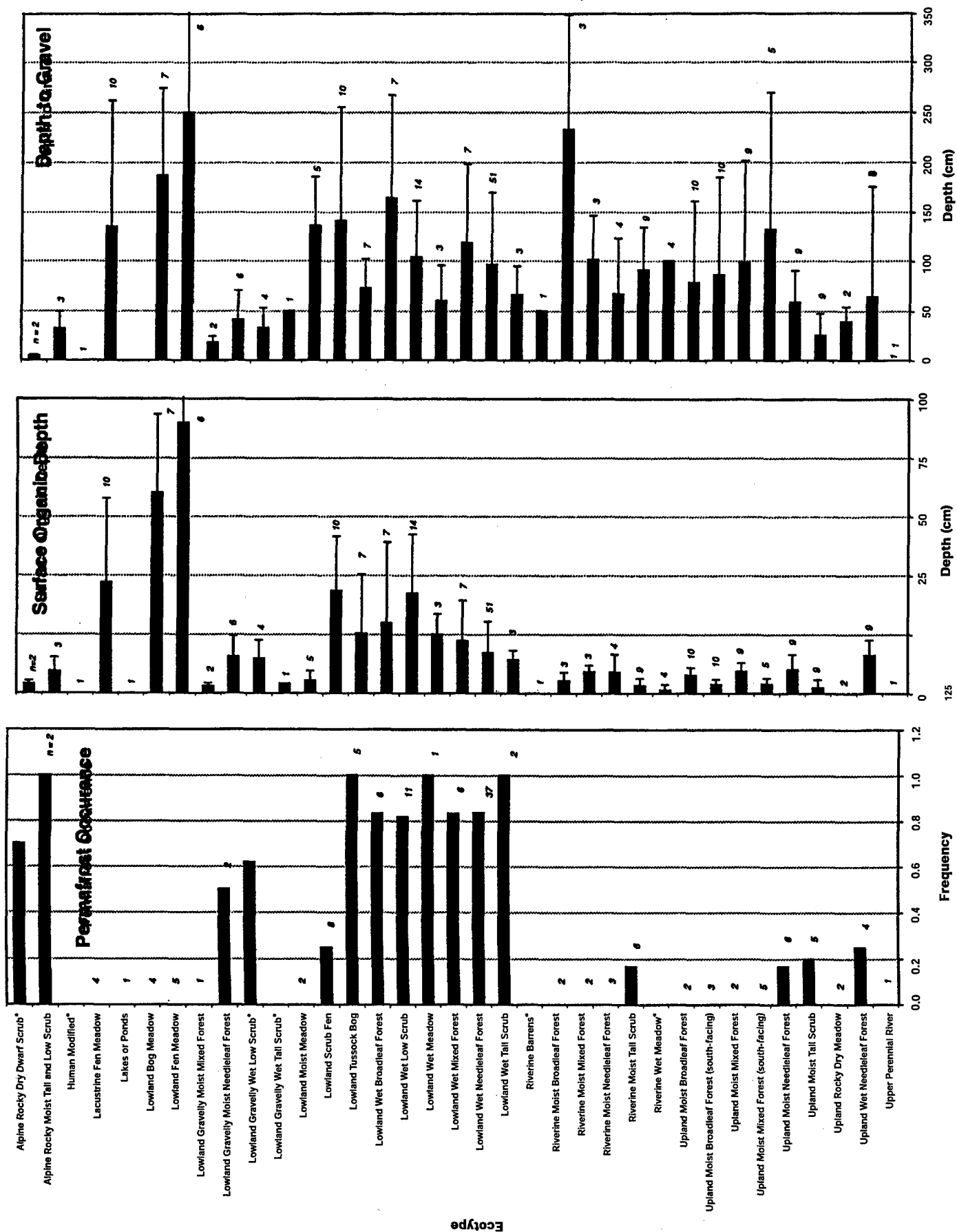
#### Soil properties

A comparison of soil properties among ecotypes reveals large differences in permafrost occurrence, surface organic depth, depth to gravel, pH, electrical conductivity, and water depth (Fig. 26 and 27). Ecotypes were grouped by physiography to facilitate comparisons.

Permafrost almost always was present in lowland ecotypes, except Lowland Moist Meadow, Lowland Gravelly Moist Mixed Forest, Lowland Gravelly Wet Tall Scrub, Lowland Bog Meadow, and Lowland Fen Meadow. Permafrost almost always was absent in the riverine ecotypes. Permafrost usually was absent in upland ecotypes, except for Upland Wet Needleleaf Forest, which was frozen in one-third of the plots.

Surface organic matter depths (uninterrupted O horizons at the surface) were greatest in the Lowland Bog Meadow and Lowland Fen Meadow that develop after thermokarst. Most lowland ecotypes also had relatively thick organic layers, with mean thicknesses ranging between 20 and 40 cm. In contrast, riverine and upland ecotypes usually had mean organic thicknesses <15 cm, except Upland Wet Needleleaf Forest, which had a mean thickness of 16 cm.

Depths to gravel were highly variable among ecotypes. Reliable comparisons were made more difficult, because depth to gravel frequently was not determined when it occurred at depths greater than the soil pit, or when the presence of permafrost limited probing for gravel. In general, however, depth to gravel was deepest in the Lowland



\* Permafrost frequency estimated

Figure 26. Frequency of permafrost occurrence, and mean ( $\pm$ SD) surface organic matter depths and depth to gravel in ecotypes within Ft Wainwright, central Alaska, 1998.



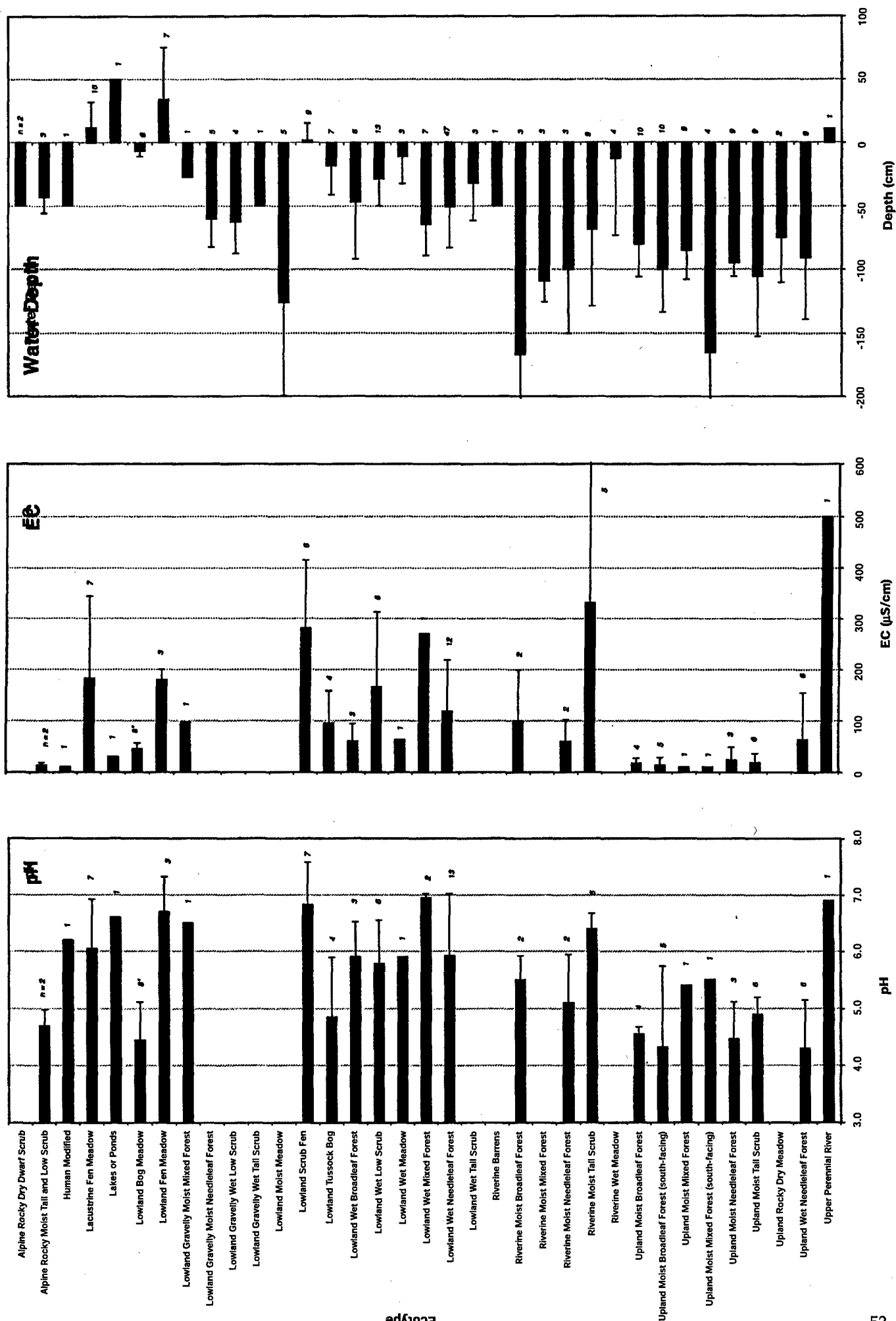


Figure 27. Mean ( $\pm$ SD) pH (soil or water), electrical conductivity (EC), and water depths in ecotypes within Ft. Wainwright, central Alaska, 1998.

Bog and Fen Meadows and shallowest in the gravelly lowland and alpine ecotypes.

Soil pH (either in soil paste or soil water) was highly variable among ecotypes. Soil pH was highest (typically >6) in Lowland Fen Meadow, Lowland Scrub Fen, Lowland Wet Mixed Forest, and Riverine Moist Tall Scrub. These ecotypes generally are affected by groundwater or sedimentation and tend to be early successional types. Lowest values (typically <5) were found in Lowland Tussock Bog, Upland Moist Broadleaf Forest, Upland Moist Needleleaf Forest, and Upland Wet Needleleaf Forest.

Soil electrical conductivity (EC) generally was low for all ecotypes because of the lack of soluble salts. Highest values (typically >200  $\mu\text{S}/\text{cm}$ ) occurred in Lowland Fen Meadow, Lowland Scrub Fen, Lowland Wet Mixed Forest, Riverine Moist Tall Scrub, and Lower Perennial River. These ecotypes generally are affected by groundwater movement or frequent sedimentation. Lowest values (typically <50  $\mu\text{S}/\text{cm}$ ) occurred in alpine and upland ecotypes. These ecotypes generally are subject to downward leaching of soluble salts and lack surface sediment or groundwater input.

Water depths generally were above the surface for Lakes and Ponds, Lacustrine Fen Meadow, Lowland Fen Meadow, and Lowland Scrub Fen. Wet ecotypes had water depths within 50 cm below the surface, except Lowland Gravelly Wet Low Scrub, Lowland Wet Mixed Forest, and Upland Wet Needleleaf Forest. These latter types tended to have highly variable water depth and soil moisture conditions, and thus they were problematic in terms of assigning a general moisture condition. Alpine and upland ecotypes generally had water depths >75 cm below the surface, but positive determinations were infrequent because water generally occurred at great depths or rocky material prevented deep sampling.

### **Ecosystem dynamics**

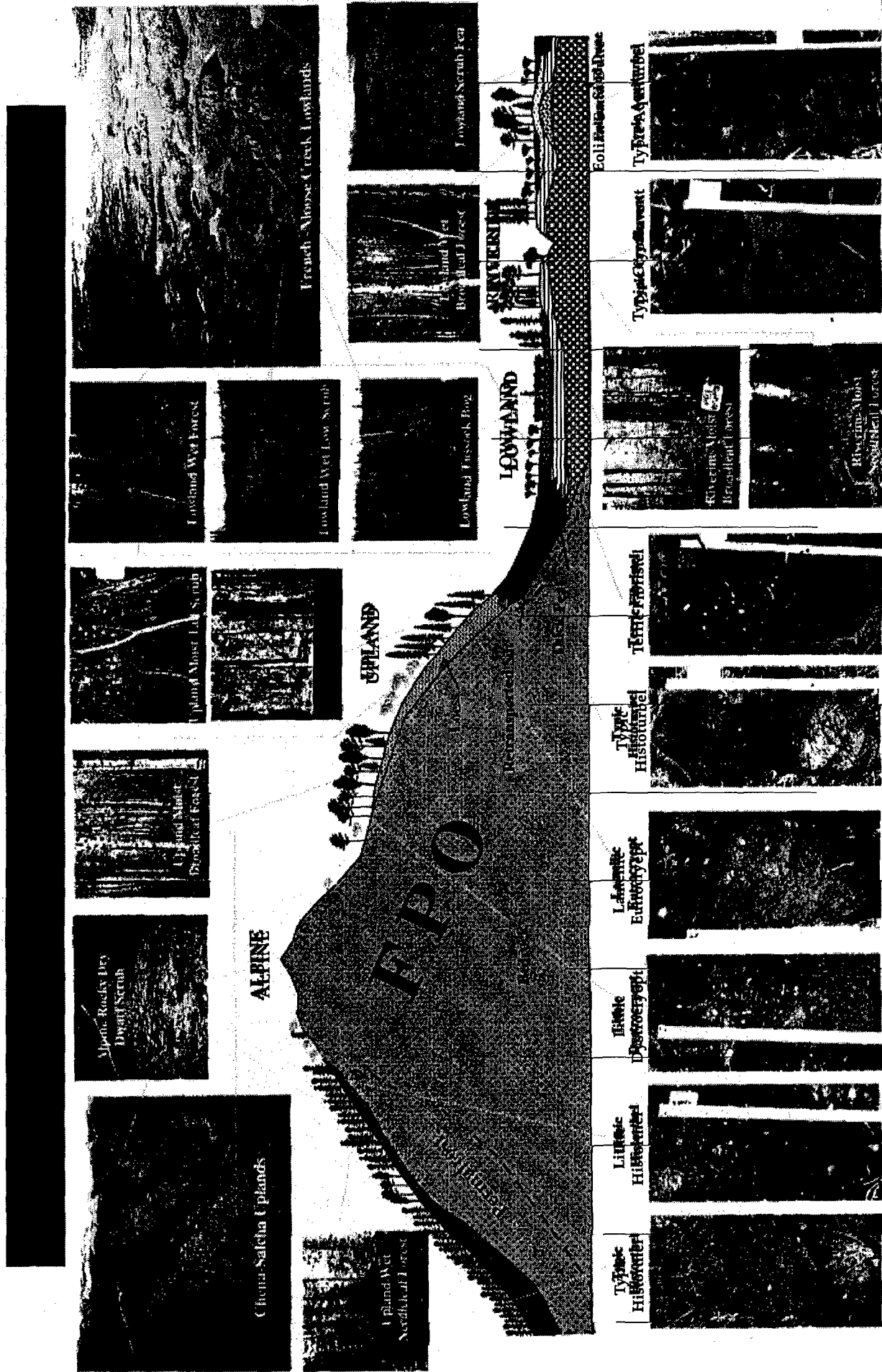
Ecosystems not only have a spatial component as described in the previous results, but also change over time in response to disturbance and successional change. We identified the principal factors affecting the dynamics of ecosystems within the study area to be fluvial processes associated with channel migration and flooding, thermokarst in ice-rich permafrost, fires that mostly are associated with lightning strikes, and human disturbances. In the following discussion, we identify the ecotypes associated with the vari-

ous disturbances and describe the general conceptual models that have been developed to relate ecological changes over time in response to these disturbances. To facilitate the discussion, we have developed simplified ecological profiles of the occurrence of ecotypes across the landscape based on the results of our analyses (Fig. 28 and 29). Disturbance processes are identified on the profiles as they relate to ecosystem patterns.

### *Fluvial processes*

Channel migration associated with the Tanana and Chena Rivers is a prominent feature of the Tanana Valley landscape, but the relative proportion of affected areas in the overall landscape was relatively small. Within the study area, the area covered by water in the Lower Perennial River was 0.6% and Riverine Barrens covered 0.2% of the area. Early (Riverine Moist Tall Scrub, 1.9% of area), mid- (Riverine Moist Broadleaf Forest, 0.9%, Riverine Moist Mixed Forest, 1.4%, Riverine Wet Low Scrub 0.1%, Riverine Complex 0.9%), and late- (Riverine Moist Needleleaf Forest, 1.8%) successional ecotypes, which have developed after the initial disturbance, occupy 8% of the total landscape.

Previous studies have found a characteristic pattern of vegetation succession along riverbanks in interior Alaska (Drury 1956, Viereck 1970, and Viereck et al. 1993) that correspond well to the ecotypes that we mapped on river floodplains. Generally, these conceptual models of floodplain succession indicate that (1) plant colonization is initiated by willows (0–5 yr for establishment) after the accumulation of sufficient sediments along the active channels occurs, (2) initial colonizers proceed through a willow-alder stage (5–10 yr), (3) forest stands develop through overstory dominance by balsam poplar (20–100 yr), (4) mixed stands with poplar and white spruce (100–200 yr) then develop, (5) mature white spruce (200–300 yr) replaces those stands, and (6) black spruce (>500 yr) eventually becomes dominant (Viereck et al. 1993). The principal factors affecting this successional development are decreasing sedimentation and water table levels. These are caused by increasing bank height, accumulation of organics from litter and later feather mosses, burial of organic layers by flooding that provides the characteristic soil sequence of interbedded organics, and the development of permafrost as soils become insulated by the thick organic layer. Viereck et al. (1993) conclude that life-history characteristics and flooding events are more important during the early stages of succession,



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 28. Generalized profile of ecological characteristics within the Yukon Maneuver Area, Ft. Wainwright, central Alaska, 1998.



## Permafrost

### Ecological Land Classification

Fort Wainwright, Alaska  
Yukon Maneuver Area

Permafrost—Earth materials that remain below 0°C for two years or more. Permafrost regimes are based on relationships of ecosystem components as described from field surveys. Map derived from recoding of integrated geomorphic and vegetation units.



Note: Much larger and more detailed maps and illustrations are available from the senior author.

Figure 30. Permafrost distribution in the Yukon Maneuver Area based on permafrost characteristics of ecotypes, Fort Wainwright, central Alaska, 1998.

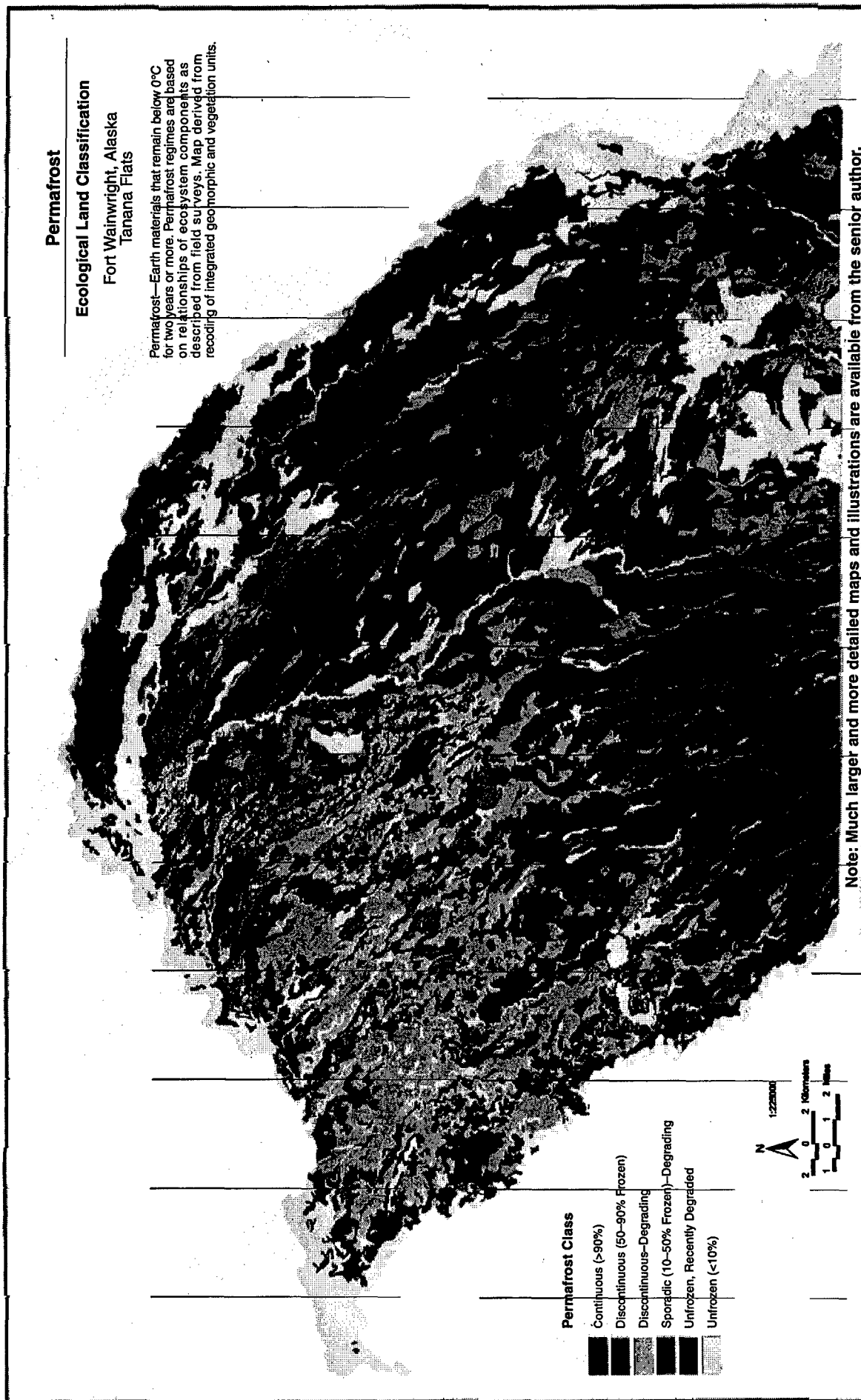


Figure 31. Permafrost distribution on the Tanana Flats based on permafrost characteristics of ecotypes, Fort Wainwright, central Alaska, 1998.

whereas biological controls such as organic matter accumulation and competition become more important in middle and late stages.

While these simplified models explain most of the variation that we observed, ecosystem development on the floodplains is more complex than the simplified models indicate. Collins (1990) quantified changes in erosional and depositional environments between 1938 and 1982 and found the braided portion of the Tanana River near Fairbanks to be highly dynamic. Mason and Beget (1991) analyzed long-term changes in depositional environmental through stratigraphic analysis and found that much of the floodplain sediments were deposited between 3000–2000 years BP. Deposition was much less after 2000 year BP, although sand units deposited during the last few hundred years indicate a period of larger flooding events. Mann et al. (1995) contributed to our understanding of the successional development of this complex fluvial landscape by providing a more detailed analysis of geomorphic processes, chronological development of fluvial sediments, and changes in plant macrofossils as indicators of paleoecosystems. Their analyses reveal that later stages of development are less straightforward than the Drury (1956) model suggests and fire becomes an important factor. In our analysis, most of the ecotypes we mapped fit the traditional successional models, but we also found small areas of Riverine Pond, Riverine Wet Meadow, and Riverine Wet Low Scrub occurring in abandoned meander channels. These ecotypes are not included in the simplified sequence of Viereck et al. (1993), but are consistent with the complexity described by Drury (1956).

#### *Thermokarst*

Much more poorly understood are successional relationships related to permafrost degradation, although a relatively large portion of the landscape, particularly on the Tanana Flats is affected by thermokarst (Fig. 30 and 31). In the entire study area, the ecotypes that generally have developed in response to thermokarst include Lowland Fen Meadow (2.8% of area), Lowland Bog Meadow (0.1%), Lowland Forest Thermokarst Complex (8.4%), Lowland Scrub Fen (2.0%), Lowland Scrub-Thermokarst Complex (10.6%), Lowland Wet Broadleaf Forest (0.6%)\*, Lowland Wet

Mixed Forest (2.4%), Lacustrine Fen Meadow (0.3%), and Lowland Wet Tall Scrub (0.6%). Overall, ~31% of the study area has undergone some degree of permafrost degradation, but degraded areas were much more prevalent on the Tanana Flats (41%) than within the YMA (5.9%).

Drury (1956) first described thermokarst processes in the upper Kuskokwim River region and the changes in vegetation associated with them, but little attention has been paid to this disturbance regime. Racine and Walters (1994) described fens on the Tanana Flats and related them to permafrost degradation and groundwater discharge from the Alaska Range. The permafrost underneath the degrading birch forests, found adjacent to the thermokarst collapse scar fens, has been found to be extremely ice-rich, in contrast to the permafrost under black spruce forests, which tends to be ice-poor (Walters et al. 1998). At the Blair Lakes Training Facility on the Tanana Flats, the permafrost table has retreated to a depth of 7–15 m (Chacho et al. 1995). In modeling the sensitivity of permafrost distribution in interior Alaska, Jorgenson and Kreig (1983) concluded, however, that permafrost was stable in some areas, particularly north-facing slopes, even with substantial climatic warming. Overall, permafrost degradation on the Tanana Flats has been found to be widespread (50% of frozen or previously frozen areas are in some stage of permafrost degradation) and rapid (Racine et al. in prep.). Stratigraphic and photographic analyses suggest that the degradation has occurred primarily during the last 200 years since the Little Ice Age.

Racine et al. (1998) described a sequence of vegetation and soil changes as permafrost degrades in a central portion of the Tanana Flats. The most rapid thawing occurs in the permafrost underlying the Lowland Wet Broadleaf Forest (dominated by *Betula papyrifera*) located next to Lowland Fen Meadow (dominated by *Menyanthes trifoliata* and *Equisetum fluviatile*). As the forest drowns along this margin, an open-water moat is colonized by minerotrophic species (mostly *Calla palustris* and *Carex rostrata*). At the same time, thawing in the interior of the birch forests produces water-filled pits (small patch size, dominated by *Bidens cernua*, *Lemna minor*, and *Potentilla palustris*) and Lowland Bog Meadow (large patch size, dominated by *Sphagnum* spp., *Eriophorum scheuchzeri*, and *Oxycoccus microcarpus*) in which ombrotrophic vegetation develops through several stages. As the thawing front moves into the birch forest from the fen, these thermokarst features become incorporated into the fen.

\* Most of this type was included in Forest Thermokarst Complex.



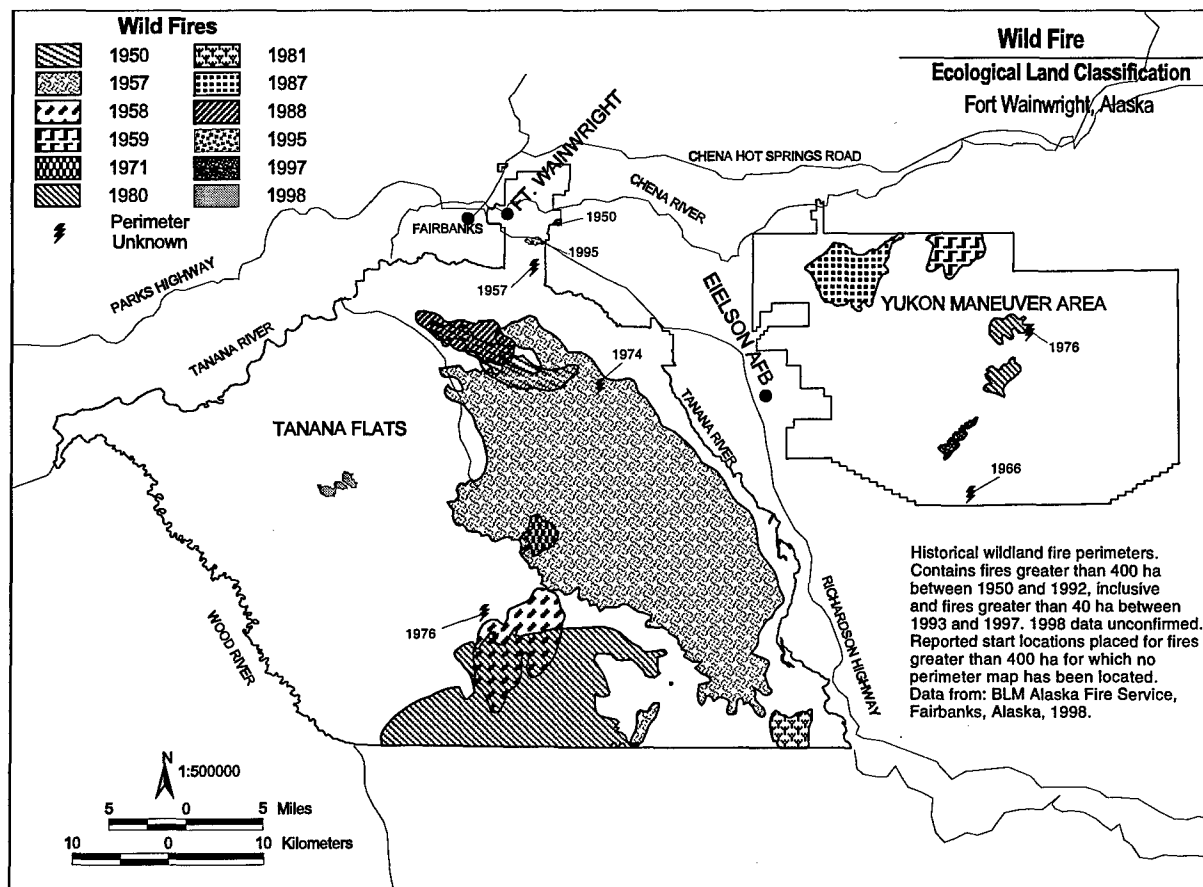


Figure 32. Distribution and extent of forest fires within Ft. Wainwright, central Alaska, 1998.

### Fire

Fire is a frequent and widespread disturbance in interior Alaska that causes well-documented stages of vegetation succession (Lutz 1956, Viereck 1973, Van Cleve et al. 1983). In our study area, compilation of forest fire distribution through historical reports and remote sensing by the Alaska Fire Service reveals that approximately 30% (110,108 ha) of the study area has been burned since 1950, although a substantial portion of this burned area (17,294 ha) has burned more than once (Fig. 32). Despite the general nature of the wild fire data (some fires are not documented and some fire perimeters may enclose unburned areas) and the difficulty in determining the successional status of some shrub communities, the fire data and vegetation data compare well. The abundance of early successional ecotypes related to fire (Upland Moist Tall Scrub, Upland Moist Low Scrub, Closed and Open Low Scrub vegetation types within Lowland Wet Low Scrub, and Lowland Gravelly Wet Low Scrub, see Table 9) indicates that ~5% of the entire study area has been burned recently (within about

30 yr). Midsuccessional ecotypes (Upland and Lowland Broadleaf and Mixed Forest types) occupy ~19% of the area. Late successional types (Upland and Lowland Needleleaf Forests) occupy ~27% of the area. The late successional types Lowland Tussock Bog and Lowland Wet Scrub (not including low scrub-post burn vegetation type), which have little tree cover and poorly understood successional development and fire history, occupied 8% of the area. Additionally, some of the thermokarst complexes include some burned areas.

Effects of fire on ecosystem development depends on the nature of the ecosystem (i.e., species, life-history characteristics, soils), and the severity and frequency of the fire (Viereck 1973, Van Cleve et al. 1983). Severity of the fire will affect how much of the organic matter on the forest floor is burned and subsequent regeneration pathways. In general, forest stands are replaced by the same tree species (Viereck 1973, Van Cleve et al. 1983). On moist upland sites (white spruce sites), Foote (1983) identified six distinct successional stages: (1) newly burned stage during 0–3 years, (2) herb-tree



stage when fast growing mosses, herbs, and tree seedlings become established after 3–10 years, (3) tall shrub–sapling stage occurring 3–30 years after fire, (4) dense tree stage of mostly birch, aspen, but also some white spruce after 15–30 years, (5) mature hardwood stage with quaking aspen and paper birch after 50–150 years, and (6) the spruce stage after 100–200 years.

The successional sequence on black spruce sites is similar in structure but varies some in species composition, and includes (1) newly burned stage with resprouting ericaceous shrubs during 0–1 years, (2) moss–herb stage when fast growing mosses, herbs, and tree seedling become established after 1–5 years, (3) tall shrub–sapling stage occurring 5–30 years after fire, (4) dense tree stage of mostly birch, aspen, and black spruce after 30–55 years, (5) mixed hardwood–spruce stage with black spruce, paper birch and quaking aspen after 55–90 years; and (6) the spruce stage with black spruce and *Sphagnum* mosses after 90–200+ years.

Fire frequencies as high as every 30–55 years has been reported for some forest types in interior Alaska (Yarie 1981). Between 1940 and 1970, nearly 1% of interior Alaska forest land burned annually (Barney 1971), whereas, since 1970, 0.6% of forested land has burned annually (Viereck and Schandelmeier 1980). Based on fire occurrences recorded on Ft. Wainwright since 1950, 1% of the area has burned annually.

### Humans

Human disturbances include cut-and-fill associated with construction of roads and pads, land clearing, excavation for impoundments, trail development, munitions testing and training, and contaminants. Of these disturbances, only roads, pads, clearings, and excavations were large or distinct enough to be mapped. Within the entire study area, human modified areas cover 0.2% of the area. Most of this type was within the YMA (531 ha) and was associated with roads. In contrast, little human disturbance (44 ha) was evident on the Tanana Flats, and principally was associated with the Blair Lakes Target Facility.

A companion study on ecological land evaluation for Ft. Wainwright is assessing the nature and magnitude of disturbance within the YMA and will provide a better analysis of disturbance regimes (Jorgenson et al., in prep.). Although little is known about the response of subarctic ecosystems to disturbance, because most research in Alaska has focused on tundra ecosystems (Van Cleve 1977, Walker et al. 1987, Slaughter et al. 1989), we provide

brief descriptions of types of human disturbances and references to pertinent literature below.

The effects of roads on forest ecosystems has been assessed briefly by Brown and Berg (1980), but major studies on ecological effects are lacking. In addition to the direct impacts, the indirect impact of dust also has significant ecological effects (Walker and Everett 1987).

Trails resulting from training exercises and recreational activities are common on both the YMA and the Tanana Flats, but little is known about the ecological changes and recovery potential for taiga ecosystems (Sparrow et al. 1978, Racine and Ahlstrand 1991). In addition, generalization of the ecological effects and recovery potential is made more difficult by the complex interactions of ecosystem characteristics, season of impacts, number of passes, type of vehicle or foot traffic, and soil and permafrost conditions.

Contaminants have been identified at 81 known or suspected areas at Ft. Wainwright and most of these were located in the main cantonment area (Kennedy et al. 1997). A wide range of contaminants have been found including pesticides, dioxin/furans, heavy metals, petroleum products, and other organic compounds. Most of this contamination was associated with leakage at buildings, tank farms, landfills, fire-training pits, drum burial sites, and coal storage. Hydrocarbon contamination of the Blair Lakes Target Facility was evaluated by Chacho et al. (1995). Little is known, however, about the nature and extent of contamination associated with explosives used in the Stuart Creek Impact Area (CEMML 1998). Contaminated areas were not mapped by our study and the ecological effects of contaminants are poorly understood.

In summary, thermokarst has had the largest overall effect (~30% of area over ~200 yr) on ecological changes. Recent fires have affected a similar amount of area (27% of area over 47 yr) based on mapping of fire occurrences. This measurement is similar to the extent of fires estimated by summing areas of early and midsuccessional ecotypes on uplands and lowlands that have developed after fire are combined (~24% over ~100 years, general age of broadleaf and mixed forests). Some fire-affected areas, however, overlap with thermokarst-affected areas so the extent of fires is underestimated somewhat. Although the extent of disturbance is similar, recovery after fire usually ends in vegetation similar to the predisturbance condition, whereas thermokarst leads to dramatically different ecosystems. Effects

of channel migration were relatively minor (~8% over ~200–300 years, general age of mature white spruce) when compared over the entire area. Human impacts have been negligible (~0.2% over ~40 years), although effects of munitions impact areas and trails have not been adequately quantified.

## SUMMARY AND CONCLUSION

An ecological land survey of Fort Wainwright land was conducted to map ecosystems at three spatial scales to aid in the management of natural resources. In an ELS, an attempt is made to view landscapes not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts that can provide a consistent conceptual framework for modeling, analyzing, interpreting, and applying ecological knowledge. More explicitly, land management activities such as ecological risk assessments, analysis, and mapping terrain sensitivity, wildlife habitats, wetland distribution, planning for training exercises, identification of rare habitats, and fire management all require spatially explicit information and a method of organizing ecological information. To provide the information required for such a wide range of applications, an ELS involves three types of efforts: (1) an ecological land survey that inventories and analyzes data obtained in the field, (2) an ecological land classification that classifies and maps ecosystem distribution, and (3) an ecological land evaluation that assesses the capabilities of the land for various land management practices.

Field surveys at 109 sites along 11 toposequences and at an additional 131 ground-reference locations were used to develop a better understanding of the ecological processes controlling landscape development in the study area. Co-varying relationships among physiography, geomorphology, hydrology, permafrost, and vegetation were identified using field survey data. The association among ecosystem components also helped identify linkages among ecosystems related to fire effects and geomorphic processes, such as groundwater discharge, floodplain development, permafrost degradation, and paludification. The association of vegetation structures (e.g., closed deciduous forests) with geomorphic units (e.g., inactive cover deposits) that was incorporated into the ecotype (local ecosystems) classification help differentiate species (e.g., balsam poplar in Riverine Broadleaf Forest vs. paper birch in Upland Broadleaf Forests).

Ecosystems were mapped at three spatial scales for the entire base. Ecotypes (1:50,000 scale) delineated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecoregions (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Although several vegetation classes can be included in an ecoregion, the vegetation classes usually are related because they occur as different stages in a successional sequence. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and hydrology, and are more synonymous with physiographic units.

This spatial database now can become the foundation for numerous management objectives such as wetland protection, integrated-training-area management, permafrost protection, wildlife management, and recreational area management. The hierarchical approach of using integrated terrain units, which can be recoded to emphasize special studies or management objectives, and the derivation of generalized ecotypes from the ITUs to partition the variability of a wide range of ecological characteristics, provides flexibility for addressing a wide range of management objectives. Development of the spatial database within a geographic information system will aid these objectives.

## LITERATURE CITED

- Allen, T.F.H., and T.B. Starr (1982) *Hierarchy: Perspectives for Ecological Complexity*. Chicago, Illinois: University of Chicago.
- Bailey, R.G. (1980) Descriptions of ecoregions of the United States. U.S. Department of Agriculture, Washington, D.C.
- Bailey, R.G. (1996) *Ecosystem Geography*. New York: Springer-Verlag.
- Bailey, R.G. (1998) *Ecoregions: The Ecosystem Geography of the Oceans and Continents*. New York: Springer-Verlag.
- Barnes, B.V., K.S. Pregitzer, T.A. Spies, and V.H. Spooner (1982) Ecological forest site classification. *Journal of Forestry*, 80: 493–498.
- Barney, R.J. (1971) Wildfires in Alaska—Some historical and projected effects and aspects. In *Proceedings, Fire in Northern Environment*. Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, p. 51–59.
- Brinson, M.M. (1993) A hydrogeomorphic classification for wetlands. USA Engineer Waterways Experiment Station, Vicksburg, Mississippi.

- Brown, A.G.** (1997) Biogeomorphology and diversity in multiple-channel river systems. *Global Ecology and Biogeography Letters*, 6: 179–85.
- Brown, D.E., F. Reichenbacher, and S.E. Franson** (1998) *A Classification of North American Biotic Communities*. Salt Lake City: University of Utah Press.
- Brown, J., and R.L. Berg, (Ed.)** (1980) Environmental engineering and ecological baseline investigations along the Yukon River–Prudhoe Bay Haul Road. USA Cold Regions Research and Engineering Laboratory, CRREL Report 80-19.
- Center for Ecological Management of Military Lands (CEMML)** (1998) Alaska Army Lands Withdrawal Renewal: Draft Legislative Environmental Impact Statement. Draft Report, prepared for U.S. Army, Ft. Richardson, Anchorage, Alaska, by Colorado State University, Ft. Collins, Colorado.
- Chacho, E.F., S.A. Arcone, and A.J. Delaney** (1995) Blair Lakes Target Facility permafrost and groundwater study. USA Cold Regions Research and Engineering Laboratory, unpublished report.
- Collins, C.M.** (1990) Morphometric analyses of recent channel changes on the Tanana River in the vicinity of Fairbanks, Alaska. USA Cold Regions Research and Engineering Laboratory, CRREL Report 90-4.
- Delcourt, H.R., and P.A. Delcourt** (1988) Quaternary landscape ecology: Relevant scales in space and time. *Landscape Ecology*, 2: 23–44.
- Driscoll, R.S., D.L. Merkel, D.L. Radloff, D.E. Snyder, and J.S. Hagihara** (1984) An ecological land classification framework for the United States. U.S. Department of Agriculture, Washington, D.C.
- Drury, W.H.** (1956) Bog flats and physiographic processes in the upper Kuskokwim River region, Alaska. *Contributions from the Gray Herbarium of Harvard University* No. CLXXVIII.
- ECOMAP** (1993) National hierarchical framework of ecological units. U.S. Forest Service, Washington, D.C.
- Ellert, B.H., M.J. Clapperton, and D.W. Anderson** (1997) An ecosystem perspective of soil quality. In *Soil Quality for Crop Production and Ecosystem Health*, (E.G. Gregorich, and M.R. Carter, Ed.), p. 115–141. Amsterdam, Netherlands: Elsevier Science Publication, *Developments in Soil Science* No. 25.
- Fitter, A.H., and R.K.M. Hay** (1987) *Environmental Physiology of Plants*. San Diego, California: Academic Press.
- Foote, M.J.** (1983) Classification, description, and dynamics of plant communities after fire in the taiga of interior Alaska. Pacific Northwest Forest and Range Experiment Station, U.S. Forest Service, Portland, Oregon.
- Forman, R.T.** (1995) *Land Mosaics: The Ecology of Landscapes and Regions*. Cambridge, UK: Cambridge University Press.
- Gallant, A. L., E. F. Binnian, J. M. Omernik, and M. B. Shasby** (1995) *Ecoregions of Alaska*. Washington, D.C.: U.S. Government Printing Office.
- Hultén, E.** (1968) *Flora of Alaska and Neighboring Territories*. Stanford, California: Stanford University Press.
- Jenny, H.** (1941) *Factors of Soil Formation*. [Reprinted in 1994] *Factors of Soil Formation, a System of Quantitative Pedology*. New York: McGraw-Hill Book Co.
- Johnson, P.L., and T.C. Vogel** (1966) Vegetation of the Yukon Flats Region, Alaska. USA Cold Regions Research and Engineering Laboratory, Research Report 209.
- Jorgenson, M.T., and R.A. Kreig** (1988) A model for mapping permafrost distribution based on landscape component maps and climatic variables. In *Proceedings, 5th International Conference on Permafrost, 2–5 August, Trondheim, Norway*. Trondheim, Norway: Tapir Publishers, vol. 1, p. 176–183.
- Jorgenson, M.T., J.E. Roth, E.R. Pullman, R.M. Burgess, M. Reynolds, A.A. Stickney, M.D. Smith, and T. Zimmer** (1997) An ecological land survey for the Colville River Delta, Alaska, 1996. Unpublished Report for ARCO Alaska, Inc., Anchorage, Alaska, by ABR, Inc., Fairbanks, Alaska.
- Jorgenson, M.T., J.E. Roth, E.R. Pullman, B.A. Anderson, and B.E. Lawhead** (in prep.). An ecological land evaluation for Ft. Wainwright and Ft. Greely assessing permafrost sensitivity, disturbance regimes, and wildlife habitat use. Prepared for USA Cold Regions Research and Engineering Laboratory, Hanover, N.H., by ABR, Inc., Fairbanks, Alaska.
- Kennedy, S.C., M.W. Johnsboy, and D.N. Cox** (1997) Postwide risk assessment. Unpublished report prepared for U.S. Army Corps of Engineers, Alaska District, Anchorage, Alaska, by Harding Lawson Associates, Denver, Colorado.
- Klijn, F., and H.A. Udo de Haes** (1994) A hierarchical approach to ecosystem and its implication for ecological land classification. *Landscape Ecology*, 9: 89–104.
- Kreig, R.A.** (1986) Terrain Unit Map, Blair Lakes, Ft. Wainwright Training Area, Alaska. Unpublished map, prepared for USA Cold Regions Research and Engineering Laboratory by R.A. Kreig and Associates, Anchorage, Alaska.

- Kreig, R.A., and R.D. Reger (1982) Air-photo analysis and summary of land-form soil properties along the route of the Trans-Alaska pipeline system. Geologic Report 66. Alaska Division of Geological and Geophysical Surveys.
- Levin, S.A. (1992) The problem of pattern and scale in ecology. *Ecology*, 73: 1943–1967.
- Lichvar, R and S. Sprecher (1998) Wetland delineation at Fort Wainwright, Alaska. Draft Report, USA Waterways Experiment Station, Vicksburg, Mississippi.
- Lutz, H.J. (1956) Ecological effects of forest fires on the vegetation of interior Alaska. Alaska Forest Research Center, U.S. Forest Service, Fairbanks, Alaska. Technical Bulletin 1131.
- Mann, D.H., C.L. Fastie, E.L. Rowland, and N.H. Bigelow (1995) Spruce succession, disturbance, and geomorphology on the Tanana River floodplain, Alaska. *Ecoscience*, 2: 184–199.
- Mason, O.K., and J.E. Beget (1991) Late Holocene flood history of the Tanana River, Alaska, U.S.A. *Arctic and Alpine Research*, 23: 392–403.
- Miall, A.D. (1985) Architectural-element analysis: A new method of facies analysis applied to fluvial deposits. *Earth Sciences Review*, 22: 261–308.
- National Wetlands Working Group (NWWG) (1988) Wetlands of Canada. Environment Canada, Montreal, Quebec.
- Nieland, B.J. (1975) Investigations of possible correlations of vegetation, substrate, and topography in Interior Alaska. Final Report prepared for U.S. Bureau of Land Management, Anchorage, Alaska, by Department of Land Resources and Agriculture, University of Alaska, Fairbanks, Alaska.
- Oberbauer, S.F., S.J. Hastings, J.L. Beyers, and W.C. Oechel (1989) Comparative effects of downslope water and nutrient movement of plant nutrition, photosynthesis, and growth in Alaskan tundra. *Holarctic Ecology*, 12: 324–334.
- O'Neil, R.V., D.L. DeAngelis, J.B. Waide, and T.F.H. Allen (1986) *A Hierarchical Concept of Ecosystems*. Princeton, N.J.: Princeton University Press.
- Péwé, T.L. (1975) Quaternary geology of Alaska. Geological Survey Professional Paper 835. U.S. Geological Survey, Washington, D.C.
- Péwé, T.L., and R.D. Reger, (Ed.) (1983) Richardson and Glenn Highways, Alaska, guidebook to permafrost and quaternary hydrology. Alaska Department of Natural Resources, Fairbanks, Alaska.
- Péwé, T.L., C. Wahrhaftig, and F. Weber (1966) Geologic map of the Fairbanks Quadrangle, Alaska. Map I-455. U.S. Geological Survey, Washington, D.C.
- Pickett, S.T., J. Kolasa, J.J. Armesto, and S.L. Collines (1989) The ecological concept of disturbance and its expression at various hierarchical levels. *Oikos*, 54: 129–36.
- Racine, C.H., and G.M. Ahlstrand (1991) Thaw response of tussock-shrub tundra to experimental all-terrain vehicle disturbance in south-central Alaska. *Arctic*, 44: 31–37.
- Racine, C.H., M.T. Jorgenson, and J.C. Walters (1998) Thermokarst vegetation in lowland birch forests on the Tanana Flats, Interior Alaska, U.S.A. In *Proceedings of 7th International Conference on Permafrost*, 23–27 June, 1998, Yellowknife, N.W.T., Canada. Ottawa, Canada: Geological Survey of Canada, p. 927–933.
- Racine, C.H., M.T. Jorgenson, J.C. Walters, T.E. Osterkamp (in prep.). Widespread and rapid permafrost degradation on the Tanana Flats in central Alaska. USA Cold Regions Research and Engineering Laboratory.
- Racine, C.H., and R. Lichvar, (1997) A floristic inventory for Fort Wainwright, Interior Alaska. USA Cold Regions Research and Engineering Laboratory, Special Report 97-23.
- Racine, C.H., and J.C. Walters (1994) Groundwater-discharge fens in the Tanana lowlands, Interior Alaska, U.S.A. *Arctic and Alpine Research*, 26: 418–426.
- Rieger, S., J.A. Dement, and D. Sanders (1963) *Soil Survey of Fairbanks Area, Alaska*. Washington, D.C.: U.S. Government Printing Office.
- Rieger, S., D.B. Schoephorster, and C.E. Furbush (1979) Exploratory soil survey of Alaska. Soil Conservation Service, U.S. Department of Agriculture, Washington, D.C.
- Rowe, J.S. (1961) The level-of-integration concept and ecology. *Ecology*, 42: 420–427.
- Shugart, H.H. (1998) *Terrestrial Ecosystems in Changing Environments*. Cambridge, UK: Cambridge University Press.
- Slaughter, C.W., C.H. Racine, D.A. Walker, L.A. Johnson, and G. Abele (1989) Use of off-road vehicles and mitigation of effects of Alaska permafrost environments: a review. *Environmental Management*, 14: 63–72.
- Soil Conservation Service and Alaska Department of Natural Resources (SCS/ANDR) (1990) Tanana River Basin study: Timber and vegetation statistics of the Tanana Valley State Forest. SCS and ADNRR, Anchorage, Alaska.
- Soil Survey Division Staff (SSDS) (1993) *Soil Survey Manual*. Washington, D.C.: U.S. Department of Agriculture.
- Soil Survey Staff (1998) *Keys to Soil Taxonomy*, 8th

ed. Washington, D.C.: U.S. Department of Agriculture.

**Sparrow, S.D., F.J. Wooding, and E.H. Whiting** (1978) Effects of off-road vehicle traffic on soils and vegetation in the Denali Highway region of Alaska. *Journal of Soil and Water Conservation*, 33: 20–27.

**Swanson, D.K., and M. Mungoven** (1998) Soil survey of Eielson Air Force Base, Alaska (an Interim Report). Natural Resource Conservation Service, Fairbanks, Alaska.

**Swanson, F.J., T.K. Kratz, N. Caine, and R.G. Woodmansee** (1988) Landform effects on ecosystem patterns and processes. *Bioscience*, 38: 92–98.

**Uhling, P.W.C., and J.K. Jordan** (1996) A spatial hierarchical framework for the co-management of ecosystems in Canada and the United States for the Upper Great Lakes Region. *Environmental Monitoring and Assessment*, 39: 59–73.

**U.S. Bureau of Land Management (USBLM)** (1997) Military Operational Area mitigation effectiveness study—habitat phase (Tanana Flats). Final Report prepared for 11th Air Force Environmental Management, U.S. Department of Defense, Elmendorf AFB, Alaska, by Bureau of Land Management, Ducks Unlimited, and Pacific Meridian Resources.

**Van Cleve, K.** (1977) Recovery of disturbed tundra and taiga surfaces in Alaska. In *Recovery and Restoration of Damaged Ecosystems* (J. Cairns, K.L. Dickson, and E.E. Herricks, Ed.), p. 422–455. *Proceedings of the International Symposium on the Recovery of Damaged Ecosystems, 23–25 March, 1977, Virginia Polytechnic Institute, Blacksburg, Virginia.*

**Van Cleve, K., and L.A. Viereck** (1983) A comparison of successional sequences following fire on permafrost-dominated and permafrost-free sites in interior Alaska. In *Proceedings, 4th International Conference on Permafrost, July 17–22, Fairbanks, Alaska*. Washington, D.C.: National Academy Press, p. 1291–1297.

**Van Cleve, K., F.S. Chapin III, C.T. Dyrness, and L.A. Viereck** (1990) Element cycling in taiga forests: State factor control. *Bioscience*, 41: 78–88.

**Van Cleve, K., F.S. Chapin III, P.W. Flanagan, L.A. Viereck, and C.T. Dyrness** (1986) *Forest Ecosystems in the Alaskan Taiga: A Synthesis of Structure and Function*. New York, N.Y.: Springer-Verlag.

**Van Cleve, K., C.T. Dyrness, L.A. Viereck, J. Fox, F.S. Chapin III, and W. Oechel** (1983) Taiga ecosystems in interior Alaska. *Bioscience*, 33: 39–44.

**Van Cleve, K., L.A. Viereck, and G.M. Marion** (1993) Introduction and overview of a study dealing with the role of salt-affected soils in primary

succession on the Tanana River floodplain, interior Alaska. *Canadian Journal of Forest Research*, 23: 879–888.

**Viereck, L.A.** (1970) Forest succession and soil development adjacent to the Chena River in interior Alaska. *Arctic and Alpine Research*, 2: 1–26.

**Viereck, L.A.** (1973) Wildlife in the taiga of Alaska. *Journal of Quaternary Research*, 3: 465–495.

**Viereck, L.A., and E.L. Little, Jr.** (1972) *Alaska Trees and Shrubs*. USDA Forest Service, Agricultural Handbook 410.

**Viereck, L.A., and L.A. Schandelmeier** (1980) Effects of fire in Alaska and adjacent Canada—A literature review. Bureau of Land Management, U.S. Department of Interior, Anchorage, Alaska.

**Viereck, L.A., and K. Van Cleve** (1984) Some aspects of vegetation and temperature relationships in the Alaska taiga. (J.H. McBeath, Ed.) In *The Potential Effects of Carbon-Dioxide-Induced Climate Changes in Alaska: The Proceedings of a Conference*, University of Alaska, Fairbanks, Alaska, p. 129–142.

**Viereck, L.A., C.T. Dyrness, A.R. Batten, and K.J. Wenzlick** (1992) *The Alaska Vegetation Classification*. Pacific Northwest Research Station, U.S. Forest Service, Portland, Oregon.

**Viereck, L.A., C.T. Dyrness, and M.J. Foote** (1993) An overview of the vegetation and soils of the floodplain ecosystems of the Tanana River, interior Alaska. *Canadian Journal of Forest Research*, 23: 889–898.

**Viereck, L.A., C.T. Dyrness, K. Van Cleve, and M.J. Foote** (1983) Vegetation, soils, and forest productivity in selected forest types in interior Alaska. *Canadian Journal of Forestry*, 13: 703–720.

**Viereck, L.A., K. Van Cleve, and C.T. Dyrness** (1986) Forest ecosystem distribution in the taiga Environment. In *Forest Ecosystems in the Alaskan Taiga: A Synthesis of Structure and Function* (K. Van Cleve, F. S. Chapin III, and P. W. Flanagan, Ed.), p. 22–43. New York: Springer-Verlag.

**Vitousek, P. M.** (1994) Factors controlling ecosystem structure and function. In *Factors of Soil Formation: A Fiftieth Anniversary Retrospective* (R. Amundsen, J. Harden, and M. Singer, Ed.), Madison, Wisconsin: Soil Science Society of America, p. 87–97.

**Vitt, D.H., J.E. Marsh, and R.B. Bovey** (1988) *Mosses, Lichens, and Ferns of Northwest North America*. Edmonton, Alberta: Lone Pine Publishing.

**Wahrhaftig, C.** (1965) Physiographic divisions of Alaska. U.S. Geological Survey, Professional Paper 482.

- Wahrhaftig, C., and R.F. Black (1965) Quaternary and engineering geology in the central part of the Alaska Range. U.S. Geological Survey, Washington, D.C.
- Walker, D.A. (1983) A hierarchical tundra vegetation classification especially designed for mapping in northern Alaska. In *Proceedings, 4th International Conference on Permafrost*, July 17–22, Fairbanks, Alaska. Washington, D.C.: National Academy Press, p. 1332–1337
- Walker, D.A. (1997) Method for making an integrated vegetation map of northern Alaska (1:4,000,000 scale). Paper presented at CAVM North American Workshop, 14–16 January 1997, Anchorage, Alaska, by Tundra Ecosystem Analysis and Mapping Laboratory, University of Colorado, Boulder.
- Walker, D.A., and K.R. Everett (1987) Road dust and its environmental impact on Alaska taiga and tundra. *Arctic and Alpine Research*, 19: 479–489.
- Walker, D.A., and M.D. Walker (1991) History and pattern of disturbance in Alaskan arctic terrestrial ecosystems: A hierarchical approach to analyzing landscape change. *Journal of Applied Ecology*, 28: 244–276.
- Walker, D.A., D. Cate, J. Brown, and C. Racine (1987) Disturbance and recovery of arctic Alaskan tundra terrain: A review of recent investigations. USA Cold Region Research and Engineering Laboratory, CRREL Report 87-11.
- Walker, D.A., E. Binnian, B.M. Evans, N.D. Lederer, E. Nordstand, and P.J. Webber (1989) Terrain, vegetation and landscape evolution of the R4D research site, Brooks Range Foothills, Alaska. *Holarctic Ecology*, 12: 238–261.
- Walker, D.A., K.R. Everett, P.J. Webber, and J. Brown (1980) Geobotanical atlas of the Prudhoe Bay region, Alaska. USA Cold Regions Research and Engineering Laboratory, CRREL Report 80-14.
- Walter, H. (1979) *Vegetation of the Earth, and Ecological Systems of the Geobiosphere*, 2nd Ed. New York: Springer-Verlag.
- Walters, J.C., C.H. Racine, and M.T. Jorgenson (1998) Characteristics of permafrost in the Tanana Flats, interior Alaska. In *Proceedings of 7th International Conference on Permafrost*, 23–27 June, 1998, Yellowknife, N.W.T., Canada. Ottawa, Canada: Geological Survey of Canada, p. 1109–1114
- Washburn, A.L. (1973) *Periglacial Processes and Environments*. London, England: Edward Arnold.
- Watt, A.S. (1947) Pattern and process in the plant community. *Journal of Ecology*, 35: 1–22.
- Wilken, E.B. (1981) Ecological land classification: Analysis and methodologies. Lands Directorate, Environment Canada, Ottawa, Canada.
- Wiken, E.B., and G. Ironside (1977) The development of ecological (biophysical) land classification in Canada. *Landscape Planning*, 4: 273–275.
- Williams, J.R. (1970) *Ground Water in the Permafrost Regions of Alaska*. Washington, D.C.: U.S. Government Printing Office.
- Yarie, J. (1981) Forest fire cycles and life tables: A case study from interior Alaska. *Canadian Journal of Forest Research*, 11: 554–262.

# Appendix A. System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	Code	Physiography	ITL code	Geomorphic name	Code	Vegetation name	Code	Ecotype name-1996
Alpine Rocky Dry Dwarf Scrub	118843	Alpine	11/273	Weathered Bedrock	11	Dryas-Lichen Dwarf Shrub Tundra	273	Alpine Scrub
Alpine Rocky Dry Dwarf Scrub	118843	Alpine	12/273	Residual Soil over Weathered Bedrock	12	Dryas-Lichen Dwarf Shrub Tundra	273	Alpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/128	Weathered Bedrock	11	Open Black Spruce-White Spruce Forest	128	Subalpine Forest
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/181	Weathered Bedrock	11	Open Spruce-Paper Birch Forest	181	Subalpine Forest
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/224	Weathered Bedrock	11	Closed Tail Alder-Willow Shrub	224	Subalpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	11/246	Weathered Bedrock	11	Closed Low Shrub Birch-Eriogonum Shrub	246	Alpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	12/253	Residual Soil over Weathered Bedrock	12	Open Low Shrub Birch-Eriogonum Shrub	253	Subalpine Scrub
Alpine Rocky Moist Tall and Low Scrub	118640	Alpine	371/253	Upland Loess	371	Partially Vegetated (>5-30% cover)	253	Subalpine Scrub
Alpine Rocky Moist Tall and Low Scrub	130000	Lowland	371/10	Lowland Loess	371	Partially Vegetated (>5-30% cover)	253	Subalpine Scrub
Human Modified	130000	Lowland	385/10	Lowland Retransported Deposits	385	Partially Vegetated (>5-30% cover)	253	Subalpine Scrub
Human Modified	130000	Lowland	520/10	Lowland Retransported Deposits	520	Partially Vegetated (>5-30% cover)	253	Subalpine Scrub
Human Modified	130000	Human Modified	780/0	Human-made Deposits	780	Barren (<5% vegetated)	0	Human Modified
Human Modified	130000	Human Modified	780/10	Human-made Deposits	780	Partially Vegetated (>5-30% cover)	10	Human Modified
Human Modified	130000	Human Modified	876/10	Water-filled Excavation	876	Partially Vegetated (>5-30% cover)	10	Human Modified
Human Modified	130000	Human Modified	994	Water-filled Excavation	994	Partially Vegetated (>5-30% cover)	10	Human Modified
Lacustrine Fen Meadow	41456	Lacustrine	854/339	Shore Fen/Lacustrine	854	Subarctic Lowland Sedge-Herb Bog Meadow	339	Bog Meadow
Lacustrine Fen Meadow	41456	Lacustrine	854/340	Shore Fen/Lacustrine	854	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lacustrine Fen Meadow	41456	Lacustrine	854/368	Shore Fen/Lacustrine	854	Subarctic Lowland Herb Bog Meadow	368	Fen Meadow
Lacustrine Wet Meadow (not mapped)	40453	Lacustrine	750/340	Lacustrine	750	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lakes or Ponds	40220	Lacustrine	750/386	Lacustrine	750	Fresh Pondweed	386	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	917	Spring	917	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	927	Deep Isolated Lake, bedrock	927	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	943	Shallow Isolated Ponds, riverine	943	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	944	Shallow Isolated Ponds, thaw	944	Water (<5% vegetated)	1	Lakes or Ponds
Lakes or Ponds	40220	Lacustrine	944	Shallow Isolated Ponds, thaw	944	Water (<5% vegetated)	1	Lakes or Ponds
Lower Perennial River	30215	Riverine	906	Lower Perennial River, nonglacial	906	Water (<5% vegetated)	1	River
Lowland Abandoned Channel Complex	50463	Lowland	907	Abandoned Floodplain, Riverine	907	Water (<5% vegetated)	1	River
Lowland Abandoned Channel Complex	50463	Lowland	452/340	Abandoned Floodplain, Riverine	452	Subarctic Lowland Sedge Wet Meadow	340	Lowland Abandoned Channel Complex
Lowland Abandoned Channel Complex	50463	Lowland	458/435	Abandoned Floodplain, Riverine	458	Slope Drainage Complex	435	Lowland Abandoned Channel Complex
Lowland Abandoned Channel Complex	50463	Lowland	715/340	Abandoned Floodplain, Riverine	715	Subarctic Lowland Sedge Wet Meadow	340	Lowland Abandoned Channel Complex
Lowland Abandoned Channel Complex	51455	Lowland	874/343	Glacioluvial Outwash, Abandoned Cover	874	Subarctic Lowland Sedge-Moss Bog Meadow	343	Bog Meadow
Lowland Abandoned Channel Complex	51455	Lowland	888/343	Glacioluvial Outwash, Abandoned Cover	888	Subarctic Lowland Sedge-Moss Bog Meadow	343	Bog Meadow
Lowland Abandoned Channel Complex	50089	Lowland	371/415	Vener Bog	371	Lowland Eolian Complex	415	Lowland Eolian Complex
Lowland Abandoned Channel Complex	50089	Lowland	385/415	Lowland Eolian Complex	385	Lowland Eolian Complex	415	Lowland Eolian Complex
Lowland Abandoned Channel Complex	50089	Lowland	520/415	Lowland Retransported Deposits	520	Lowland Eolian Complex	415	Lowland Eolian Complex
Lowland Abandoned Channel Complex	51456	Lowland	507/471	Lowland Retransported Deposits	507	Paludification Complex, (wet forb-seed) fen	471	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	843/471	Drainage (or Channel) Fen	843	Subarctic Lowland Sedge Wet Meadow	471	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	843/471	Drainage (or Channel) Fen	843	Subarctic Lowland Sedge Wet Meadow	471	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	844/368	Collapse Scar Fen	844	Subarctic Lowland Sedge Wet Meadow	368	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	844/368	Collapse Scar Fen	844	Subarctic Lowland Sedge Wet Meadow	368	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	844/471	Collapse Scar Fen	844	Subarctic Lowland Sedge Wet Meadow	471	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	874/368	Collapse Scar Fen	874	Subarctic Lowland Sedge Wet Meadow	368	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	874/471	Collapse Scar Fen	874	Subarctic Lowland Sedge Wet Meadow	471	Fen Meadow
Lowland Abandoned Channel Complex	51456	Lowland	876/340	Flat Bog/Floodplain	876	Subarctic Lowland Sedge Wet Meadow	340	Fen Meadow
Lowland Abandoned Channel Complex	50074	Lowland	465/531	Abandoned Floodplain, Cover + Organic Bog	465	Thermokarst Complex, black spruce-collapse scar bog	531	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	465/533	Abandoned Floodplain, Cover + Organic Bog	465	Thermokarst Complex, black spruce-collapse scar bog	533	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	465/534	Abandoned Floodplain, Cover + Organic Bog	465	Thermokarst Complex, black spruce-collapse scar bog	534	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	508/531	Alluvial Fan Abandoned Cover + Organic Bog	508	Thermokarst Complex, mixed spruce-collapse scar bog	531	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	508/534	Alluvial Fan Abandoned Cover + Organic Bog	508	Thermokarst Complex, mixed spruce-collapse scar bog	534	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	717/531	Glacioluvial Outwash + Organic Bog	717	Thermokarst Complex, black spruce-collapse scar bog	531	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	717/534	Glacioluvial Outwash + Organic Bog	717	Thermokarst Complex, black spruce-collapse scar bog	534	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	719/531	Dissected Glacioluvial Outwash Cover + Organic Bog	719	Thermokarst Complex, black spruce-collapse scar bog	531	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	719/534	Dissected Glacioluvial Outwash Cover + Organic Bog	719	Thermokarst Complex, black spruce-collapse scar bog	534	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	458/144	Abandoned Floodplain, Riverine	458	Closed Paper Birch Forest	144	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	507/144	Alluvial Fan Abandoned Riverbed Deposit	507	Closed Paper Birch Forest	144	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	507/146	Alluvial Fan Abandoned Riverbed Deposit	507	Closed Paper Birch Forest	146	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	705/151	Glacioluvial Outwash Abandoned Riverbed	705	Closed Paper Birch Forest	151	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	705/165	Glacioluvial Outwash Abandoned Riverbed	705	Closed Paper Birch Forest	165	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	451/171	Abandoned Floodplain, Riverbed Deposit, recent	451	Closed Spruce-Paper Birch Forest	171	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	451/172	Abandoned Floodplain, Riverbed Deposit, recent	451	Closed Spruce-Paper Birch Forest	172	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	451/182	Abandoned Floodplain, Riverbed Deposit, recent	451	Closed Spruce-Paper Birch Forest	182	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	458/171	Abandoned Floodplain, Riverbed Deposit, recent	458	Closed Spruce-Paper Birch Forest	171	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	458/181	Abandoned Floodplain, Riverbed Deposit, recent	458	Closed Spruce-Paper Birch Forest	181	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	507/171	Alluvial Fan Abandoned Riverbed Deposit	507	Closed Spruce-Paper Birch Forest	171	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	507/181	Alluvial Fan Abandoned Riverbed Deposit	507	Closed Spruce-Paper Birch Forest	181	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	705/181	Glacioluvial Outwash Abandoned Riverbed	705	Closed Spruce-Paper Birch Forest	181	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	371/114	Lowland Loess	371	Closed Spruce-Paper Birch Forest	114	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	451/115	Abandoned Floodplain, Riverbed Deposit, recent	451	Closed Black Spruce Forest	115	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	451/116	Abandoned Floodplain, Riverbed Deposit, recent	451	Closed Black Spruce Forest	116	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	451/124	Abandoned Floodplain, Riverbed Deposit, recent	451	Closed Black Spruce Forest	124	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	458/113	Abandoned Floodplain, Riverbed Deposit, recent	458	Closed Black Spruce Forest	113	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	458/114	Abandoned Floodplain, Riverbed Deposit, recent	458	Closed Black Spruce Forest	114	Lowland Forest-Thermokarst Complex
Lowland Abandoned Channel Complex	50074	Lowland	458/125	Abandoned Floodplain, Riverbed Deposit, recent	458	Closed Black Spruce Forest	125	Lowland Forest-Thermokarst Complex



Ecotype name-1998	Code	Physiognomy	ITU code	Geomorphic name	Code	Vegetation name	Code	Ecotype name-1996
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	458/1127	Abandoned Floodplain-Gravel	458	Open Black Spruce-Tamarack Forest	127	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	501/1113	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Black Spruce Forest	113	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	501/1114	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Black Spruce-White Spruce Forest	114	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	501/125	Alluvial Fan Abandoned Riverbed Deposit	501	Open Black Spruce Forest	125	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	501/128	Alluvial Fan Abandoned Riverbed Deposit	501	Open Black Spruce-White Spruce Forest	128	Lowland Forest (Gravelly)
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	705/112	Glaciofluvial Outwash Abandoned Riverbed	705	Closed White Spruce Forest	112	Lowland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	705/114	Glaciofluvial Outwash Abandoned Riverbed	705	Closed Black Spruce-Tamarack Forest	114	Upland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	705/125	Glaciofluvial Outwash Abandoned Riverbed	705	Open Black Spruce Forest	125	Upland Needleleaf Forest
Lowland Gravelly Moist Needleleaf Forest	59631	Lowland	705/127	Glaciofluvial Outwash Abandoned Riverbed	705	Open Black Spruce-Tamarack Forest	127	Upland Needleleaf Forest
Lowland Gravelly Wet Low Scrub	59442	Lowland	705/136	Glaciofluvial Outwash Abandoned Riverbed	705	Mixed Conifer Woodland	136	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	59442	Lowland	705/249	Glaciofluvial Outwash Abandoned Riverbed	705	Closed Low Scrub Birch-Ericaceous Shrub	249	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	59442	Lowland	705/259	Glaciofluvial Outwash Abandoned Riverbed	705	Closed Low Scrub	259	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	59442	Lowland	451/246	Abandoned Floodplain-Gravel	451	Open Low Scrub (post burn, disturbance)	246	Upland Low Scrub
Lowland Gravelly Wet Low Scrub	59442	Lowland	458/136	Abandoned Floodplain-Gravel	458	Closed Low Scrub Birch-Ericaceous Shrub	136	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	59442	Lowland	458/246	Abandoned Floodplain-Gravel	458	Mixed Conifer Woodland	246	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	59442	Lowland	458/249	Abandoned Floodplain-Gravel	458	Closed Low Scrub Birch-Ericaceous Shrub	249	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	59442	Lowland	501/262	Abandoned Floodplain-Gravel	501	Closed Low Scrub	262	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Low Scrub	59442	Lowland	718/224	Alluvial Fan Abandoned Riverbed Deposit	718	Open Low Willow-Graminoid Shrub Bog	224	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	59441	Lowland	458/165	Dissected Glaciofluvial Outwash Cover	458	Closed Tall Alder-Willow Shrub	165	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	59441	Lowland	458/226	Abandoned Floodplain-Gravel	458	Broadleaf-Scrub Woodland	226	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	59441	Lowland	458/226	Abandoned Floodplain-Gravel	458	Closed Tall Alder-Willow Shrub	226	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	59441	Lowland	501/224	Alluvial Fan Abandoned Riverbed Deposit	501	Open Tall Shrub Swamp	224	Lowland Scrub (Gravelly)
Lowland Gravelly Wet Tall Scrub	59441	Lowland	501/236	Alluvial Fan Abandoned Riverbed Deposit	501	Closed Tall Alder-Willow Shrub	236	Lowland Scrub (Gravelly)
Lowland Moist Meadow	59652	Lowland	371/311	Lowland Loess	371	Open Tall Shrub Swamp	311	Lowland Scrub (Gravelly)
Lowland Moist Meadow	59652	Lowland	385/311	Lowland Eolian Complex	385	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	59652	Lowland	447/311	Meander Inactive Floodplain Cover Deposit	447	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	59652	Lowland	452/311	Abandoned Floodplain Cover Deposit	452	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	59652	Lowland	520/311	Lowland Retransported Deposits	520	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Moist Meadow	59652	Lowland	718/311	Dissected Glaciofluvial Outwash Cover	718	Bluejoint Meadow	311	Lowland Moist Meadow
Lowland Scrub Fen	51445	Lowland	452/262	Abandoned-floodplain Cover Deposit	452	Open Low Willow-Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	505/262	Alluvial Fan Abandoned Cover Deposit	505	Open Low Willow-Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	715/262	Glaciofluvial Outwash Abandoned Cover	715	Open Low Willow-Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	718/262	Dissected Glaciofluvial Outwash Cover	718	Open Low Willow-Graminoid Shrub Bog	262	Lowland Low Scrub
Lowland Scrub Fen	51445	Lowland	835/226	Peat Swamp Margin	835	Open Tall Shrub Swamp	226	Scrub Fen
Lowland Scrub Fen	51445	Lowland	843/236	Drainage (or Channel) Fen	843	Open Tall Shrub Swamp	236	Scrub Fen
Lowland Scrub Fen	51445	Lowland	843/262	Drainage (or Channel) Fen	843	Open Low Willow-Graminoid Shrub Bog	262	Scrub Fen
Lowland Scrub Fen	51445	Lowland	854/262	Shore Fen/Lacustrine	854	Open Low Willow-Graminoid Shrub Bog	262	Bog Meadow
Lowland Scrub Fen	51445	Lowland	874/226	Collapse Scar Bog/Floodplain	874	Open Tall Shrub Swamp	226	Scrub Fen
Lowland Scrub Fen	51445	Lowland	874/262	Collapse Scar Bog/Floodplain	874	Open Low Willow-Graminoid Shrub Bog	262	Scrub Fen
Lowland Scrub Fen	51445	Lowland	876/262	Flat Bog/Floodplain	876	Open Low Sweetgale-Graminoid Bog	262	Scrub Fen
Lowland Scrub-Thermokarst Complex	59075	Lowland	452/236	Abandoned Floodplain Cover Deposit	452	Open Tall Shrub Swamp	236	Lowland Scrub-Thermokarst Complex
Lowland Scrub-Thermokarst Complex	59075	Lowland						



# Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	Code	Physiography	ITU code	Geomorphic name	Code	Vegetation name	Code	Ecotype name-1996
Lowland Wet Broadleaf Forest	50432	Lowland	385/144	Lowland Eolian Complex	385	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	385/151	Lowland Eolian Complex	385	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452/143	Abandoned Floodplain Cover Deposit	452	Closed Balsam Poplar Forest	143	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452/144	Abandoned Floodplain Cover Deposit	452	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452/145	Abandoned Floodplain Cover Deposit	452	Closed Quaking Aspen Forest	145	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452/146	Abandoned Floodplain Cover Deposit	452	Closed Paper Birch-Quaking Aspen Forest	146	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	452/151	Abandoned Floodplain Cover Deposit	452	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	505/144	Alluvial Fan Abandoned Cover Deposit	505	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	505/151	Alluvial Fan Abandoned Cover Deposit	505	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	505/154	Alluvial Fan Abandoned Cover Deposit	505	Open Paper Birch-Quaking Aspen Forest	154	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506/144	Dissected Alluvial Fan Cover Deposit	506	Closed Paper Birch-Quaking Aspen Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506/151	Dissected Alluvial Fan Cover Deposit	506	Closed Paper Birch-Quaking Aspen Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	506/154	Dissected Alluvial Fan Cover Deposit	506	Open Paper Birch-Quaking Aspen Forest	154	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	520/144	Lowland Retransported Deposits	520	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	520/151	Lowland Retransported Deposits	520	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	715/144	Glaciofluvial Outwash Abandoned Cover	715	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	715/145	Glaciofluvial Outwash Abandoned Cover	715	Closed Quaking Aspen Forest	145	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	715/151	Glaciofluvial Outwash Abandoned Cover	715	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	718/144	Dissected Glaciofluvial Outwash Cover	718	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	718/151	Dissected Glaciofluvial Outwash Cover	718	Open Paper Birch Forest	151	Lowland Broadleaf Forest
Lowland Wet Broadleaf Forest	50432	Lowland	884/144	Peat Plateau Bog (birch forest)/Floodplain	884	Closed Paper Birch Forest	144	Lowland Broadleaf Forest
Lowland Wet Low Scrub	50442	Lowland	371/135	Lowland Loess	371	Mixed Conifer Woodland	135	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	371/136	Lowland Loess	371	Black Spruce-White Spruce Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	385/136	Lowland Eolian Complex	385	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	385/246	Lowland Eolian Complex	385	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	385/249	Lowland Eolian Complex	385	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452/136	Abandoned Floodplain Cover Deposit	452	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452/246	Abandoned Floodplain Cover Deposit	452	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452/249	Abandoned Floodplain Cover Deposit	452	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	452/259	Abandoned Floodplain Cover Deposit	452	Open Low Scrub (post burn, disturbance)	259	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	505/136	Alluvial Fan Abandoned Cover Deposit	505	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	505/246	Alluvial Fan Abandoned Cover Deposit	505	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	505/249	Alluvial Fan Abandoned Cover Deposit	505	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	506/136	Dissected Alluvial Fan Cover Deposit	506	Closed Low Scrub	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	506/246	Dissected Alluvial Fan Cover Deposit	506	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	506/249	Dissected Alluvial Fan Cover Deposit	506	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	520/136	Lowland Retransported Deposits	520	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	520/246	Lowland Retransported Deposits	520	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	520/249	Lowland Retransported Deposits	520	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715/136	Glaciofluvial Outwash Abandoned Cover	715	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715/246	Glaciofluvial Outwash Abandoned Cover	715	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	715/249	Glaciofluvial Outwash Abandoned Cover	715	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718/136	Dissected Glaciofluvial Outwash Cover	718	Open Low Scrub (post burn, disturbance)	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718/246	Dissected Glaciofluvial Outwash Cover	718	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718/249	Dissected Glaciofluvial Outwash Cover	718	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	718/259	Dissected Glaciofluvial Outwash Cover	718	Closed Low Scrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	874/136	Dissected Glaciofluvial Outwash Cover	874	Open Low Scrub (post burn, disturbance)	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	874/246	Collapse Scar Bog/Floodplain	874	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	876/136	Flat Bog/Floodplain	876	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	876/246	Flat Bog/Floodplain	876	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	885/246	Shore Bog (nonfloating)/Lacustrine	885	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	885/249	Shore Bog (nonfloating)/Lacustrine	885	Closed Low Scrub	249	Lowland Low Scrub
Lowland Wet Low Scrub	50442	Lowland	888/136	Veneer Bog	888	Closed Low Scrub Birch-Ericaceous Shrub	246	Lowland Low Scrub
Lowland Wet Meadow (not mapped)	50453	Lowland	458/340	Abandoned Floodplain-Gravel	458	Mixed Conifer Woodland	136	Lowland Low Scrub
Lowland Wet Meadow (not mapped)	50453	Lowland	505/340	Alluvial Fan Abandoned Cover Deposit	505	Subarctic Lowland Sedge Wet Meadow	340	Lowland Low Scrub
Lowland Wet Mixed Forest	50433	Lowland	371/171	Lowland Loess	371	Subarctic Lowland Sedge Wet Meadow	340	Lowland Low Scrub
Lowland Wet Mixed Forest	50433	Lowland	371/181	Lowland Loess	371	Closed Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	385/171	Lowland Eolian Complex	385	Open Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	385/181	Lowland Eolian Complex	385	Closed Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/171	Abandoned Floodplain Cover Deposit	452	Closed Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/173	Abandoned Floodplain Cover Deposit	452	Closed Spruce-Paper Birch-Quaking Aspen Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/175	Abandoned Floodplain Cover Deposit	452	Closed Balsam Poplar-White Spruce Forest	175	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/181	Abandoned Floodplain Cover Deposit	452	Closed Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/171	Alluvial Fan Abandoned Cover Deposit	505	Open Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/181	Alluvial Fan Abandoned Cover Deposit	505	Closed Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506/171	Dissected Alluvial Fan Cover Deposit	506	Open Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506/173	Dissected Alluvial Fan Cover Deposit	506	Closed Spruce-Paper Birch Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506/181	Dissected Alluvial Fan Cover Deposit	506	Closed Spruce-Paper Birch-Quaking Aspen Forest	181	Lowland Mixed Forest

# Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecosystem classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	Code	Physiography	ITU code	Geomorphic name	Code	Vegetation name	Code	Ecotype name-1996
Lowland Wet Mixed Forest	50433	Lowland	520/171	Lowland Retransported Deposits	520	Closed Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/181	Glaciofluvial Outwash Abandoned Cover	520	Open Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/171	Glaciofluvial Outwash Abandoned Cover	520	Closed Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/173	Glaciofluvial Outwash Abandoned Cover	715	Closed Spruce-Paper Birch Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/181	Glaciofluvial Outwash Abandoned Cover	715	Open Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/182	Glaciofluvial Outwash Abandoned Cover	715	Open Quaking Aspen-Spruce Forest	182	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/171	Dissected Glaciofluvial Outwash Cover	718	Closed Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/173	Dissected Glaciofluvial Outwash Cover	718	Closed Spruce-Paper Birch-Quaking Aspen Forest	173	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/181	Dissected Glaciofluvial Outwash Cover	718	Open Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	876/171	Dissected Glaciofluvial Outwash Cover	876	Closed Spruce-Paper Birch Forest	171	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	876/181	Dissected Glaciofluvial Outwash Cover	876	Open Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	884/181	Flat Bog/Floodplain	884	Open Spruce-Paper Birch Forest	181	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	371/113	Flat Bog/Floodplain	371	Open Spruce-Paper Birch Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	371/125	Lowland Loess	371	Closed Black Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	371/127	Lowland Loess	371	Open Black Spruce Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	371/211	Lowland Loess	371	Open Black Spruce-Tamarack Forest	211	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	385/113	Lowland Loess	385	Open Black Spruce-Tamarack Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/112	Lowland Eolian Complex	452	Closed Black Spruce Forest	112	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/113	Abandoned Floodplain Cover Deposit	452	Closed White Spruce Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/114	Abandoned Floodplain Cover Deposit	452	Closed Black Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/124	Abandoned Floodplain Cover Deposit	452	Closed Black Spruce-White Spruce Forest	124	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/125	Abandoned Floodplain Cover Deposit	452	Open White Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/127	Abandoned Floodplain Cover Deposit	452	Open Black Spruce Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	452/128	Abandoned Floodplain Cover Deposit	452	Open Black Spruce-Tamarack Forest	128	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	455/113	Abandoned Floodplain Cover Deposit, recent	455	Open Black Spruce-White Spruce Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	455/114	Abandoned Floodplain Cover Deposit, recent	455	Closed Black Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/113	Alluvial Fan Abandoned Cover Deposit	505	Closed Black Spruce-White Spruce Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/114	Alluvial Fan Abandoned Cover Deposit	505	Closed Black Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/125	Alluvial Fan Abandoned Cover Deposit	505	Closed Black Spruce-White Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/127	Alluvial Fan Abandoned Cover Deposit	505	Closed Black Spruce-Tamarack Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	505/128	Alluvial Fan Abandoned Cover Deposit	505	Open Black Spruce Forest	128	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506/114	Dissected Alluvial Fan Cover Deposit	506	Open Black Spruce-White Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506/125	Dissected Alluvial Fan Cover Deposit	506	Closed Black Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	506/127	Dissected Alluvial Fan Cover Deposit	506	Open Black Spruce-Tamarack Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/113	Lowland Retransported Deposits	520	Closed Black Spruce-White Spruce Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/114	Lowland Retransported Deposits	520	Closed Black Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/125	Lowland Retransported Deposits	520	Closed Black Spruce-White Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	520/127	Lowland Retransported Deposits	520	Open Black Spruce-Tamarack Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/112	Glaciofluvial Outwash Abandoned Cover	715	Closed White Spruce Forest	112	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/113	Glaciofluvial Outwash Abandoned Cover	715	Closed Black Spruce Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/114	Glaciofluvial Outwash Abandoned Cover	715	Closed Black Spruce-White Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/125	Glaciofluvial Outwash Abandoned Cover	715	Open Black Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	715/127	Glaciofluvial Outwash Abandoned Cover	715	Open Black Spruce-Tamarack Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/113	Glaciofluvial Outwash Abandoned Cover	718	Open Black Spruce-White Spruce Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/114	Glaciofluvial Outwash Abandoned Cover	718	Closed Black Spruce Forest	114	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/125	Dissected Glaciofluvial Outwash Cover	718	Closed Black Spruce-White Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	718/127	Dissected Glaciofluvial Outwash Cover	718	Open Black Spruce Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	876/113	Dissected Glaciofluvial Outwash Cover	876	Closed Black Spruce-Tamarack Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	885/127	Shore Bog (nonfloating)/Lacustrine	885	Open Black Spruce Forest	127	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	888/113	Vener Bog	888	Open Black Spruce-Tamarack Forest	113	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	888/125	Vener Bog	888	Closed Black Spruce Forest	125	Lowland Mixed Forest
Lowland Wet Mixed Forest	50433	Lowland	371/224	Lowland Loess	371	Closed Black Spruce-Tamarack Forest	224	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	452/165	Abandoned Floodplain Cover Deposit	452	Broadleaf-Scrub Woodland	165	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	452/224	Abandoned Floodplain Cover Deposit	452	Closed Black Spruce-White Spruce Forest	224	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	480/236	Headwater Floodplain, Small Watercourse	480	Open Black Spruce-Tamarack Forest	236	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	505/165	Alluvial Fan Abandoned Cover Deposit	505	Broadleaf-Scrub Woodland	165	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	506/165	Dissected Alluvial Fan Cover Deposit	506	Broadleaf-Scrub Woodland	165	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	520/165	Lowland Retransported Deposits	520	Broadleaf-Scrub Woodland	165	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	520/224	Lowland Retransported Deposits	520	Closed Black Spruce-White Spruce Forest	224	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	715/165	Glaciofluvial Outwash Abandoned Cover	715	Broadleaf-Scrub Woodland	165	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	718/165	Dissected Glaciofluvial Outwash Cover	718	Broadleaf-Scrub Woodland	165	Lowland Mixed Forest
Lowland Wet Mixed Forest	50441	Lowland	431/0	Braided Floodplain Riverbed Deposit	431	Barren (<5% vegetated)	0	Riverine Barrens
Riverine Barrens	30090	Riverine	435/10	Braided Active-Floodplain Riverbed Deposit	435	Partially Vegetated (>5-30% cover)	10	Riverine Barrens
Riverine Barrens	30090	Riverine	441/0	Meander Floodplain Riverbed Deposit	441	Barren (<5% vegetated)	0	Riverine Barrens
Riverine Barrens	30090	Riverine	441/10	Meander Active Floodplain Cover Deposit	441	Partially Vegetated (>5-30% cover)	10	Riverine Barrens

Ecotype name-1998	Code	Physiography	TTL code	Gemorphiz name	Code	Vegetation name	Code	Ecotype name-1996
Riverine Barrens	30090	Riverine	447/10	Meander Inactive Floodplain Cover Deposit	447	Partially Vegetated (>5-20% cover)	10	Riverine Barrens
Riverine Complex	30060	Riverine	435/20	Braided Active Floodplain Riverbed Deposit	435	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	437/20	Braided Inactive Floodplain Riverbed Deposit	437	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	440/20	Meander Active Floodplain, undifferentiated	440	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	445/20	Meander Active Floodplain Cover Deposit	445	Riverine Complex	420	Riverine Complex
Riverine Complex	30060	Riverine	447/20	Headwater Floodplain, Small Watercourse	447	Riverine Complex	420	Riverine Complex
Riverine Moist Broadleaf Forest	30032	Riverine	480/20	Braided Active Floodplain, Riverbed Deposit	480	Closed Balsam Poplar Forest	143	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30032	Riverine	437/143	Braided Active Floodplain Cover Deposit	437	Closed Balsam Poplar Forest	143	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30032	Riverine	437/143	Meander Inactive Floodplain Cover Deposit	447	Closed Balsam Poplar Forest	143	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30032	Riverine	447/144	Meander Inactive Floodplain Cover Deposit	447	Closed Quaking Aspen Forest	144	Riverine Broadleaf Forest
Riverine Moist Broadleaf Forest	30032	Riverine	447/151	Meander Inactive Floodplain Cover Deposit	447	Open Paper Birch Forest	151	Riverine Broadleaf Forest
Riverine Moist Mixed Forest	30033	Riverine	437/171	Braided Inactive Floodplain Cover Deposit	437	Closed Spruce-Paper Birch Forest	171	Riverine Mixed Forest
Riverine Moist Mixed Forest	30033	Riverine	437/175	Braided Inactive Floodplain Cover Deposit	437	Closed Spruce-Paper Birch Forest	175	Riverine Mixed Forest
Riverine Moist Mixed Forest	30033	Riverine	447/173	Meander Inactive Floodplain Cover Deposit	447	Closed Spruce-Paper Birch-Quaking Aspen Forest	173	Riverine Mixed Forest
Riverine Moist Mixed Forest	30033	Riverine	447/175	Meander Inactive Floodplain Cover Deposit	447	Closed Balsam Poplar-White Spruce Forest	175	Riverine Mixed Forest
Riverine Moist Mixed Forest	30033	Riverine	447/181	Meander Inactive Floodplain Cover Deposit	447	Open Spruce-Paper Birch Forest	181	Riverine Mixed Forest
Riverine Moist Mixed Forest	30033	Riverine	480/171	Headwater Floodplain, Small Watercourse	480	Closed Spruce-Paper Birch Forest	181	Riverine Mixed Forest
Riverine Moist Mixed Forest	30033	Riverine	480/175	Headwater Floodplain, Small Watercourse	480	Closed Balsam Poplar-White Spruce Forest	181	Riverine Mixed Forest
Riverine Moist Needleaf Forest	30031	Riverine	437/111	Braided Inactive Floodplain Cover Deposit	437	Closed White Spruce Forest	111	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	437/113	Braided Inactive Floodplain Cover Deposit	437	Closed Black Spruce Forest	113	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	437/124	Braided Inactive Floodplain Cover Deposit	437	Open Black Spruce-Tamarack Forest	124	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	437/127	Braided Inactive Floodplain Cover Deposit	437	Open White Spruce Forest	127	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	447/112	Meander Inactive Floodplain Cover Deposit	447	Open Black Spruce-Tamarack Forest	127	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	447/113	Meander Inactive Floodplain Cover Deposit	447	Closed White Spruce Forest	127	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	447/114	Meander Inactive Floodplain Cover Deposit	447	Closed Black Spruce Forest	114	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	447/124	Meander Inactive Floodplain Cover Deposit	447	Open White Spruce Forest	124	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	447/125	Meander Inactive Floodplain Cover Deposit	447	Closed Black Spruce-White Spruce Forest	125	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	447/128	Meander Inactive Floodplain Cover Deposit	447	Open Black Spruce Forest	128	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	480/112	Headwater Floodplain, Small Watercourse	480	Closed White Spruce Forest	112	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	480/113	Headwater Floodplain, Small Watercourse	480	Closed Black Spruce-White Spruce Forest	113	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	480/125	Headwater Floodplain, Small Watercourse	480	Open Black Spruce Forest	125	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	480/128	Headwater Floodplain, Small Watercourse	480	Open Black Spruce-Tamarack Forest	128	Riverine Needleaf Forest
Riverine Moist Needleaf Forest	30031	Riverine	437/224	Braided Active Floodplain, Riverbed Deposit	437	Closed Tall Alder-Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	440/224	Meander Floodplain, undifferentiated	440	Closed Tall Alder-Willow Shrub	224	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	445/221	Meander Active Floodplain Cover Deposit	445	Closed Tall Willow Shrub	221	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	447/165	Meander Inactive Floodplain Cover Deposit	447	Closed Tall Alder-Willow Shrub	221	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	447/121	Meander Inactive Floodplain Cover Deposit	447	Broadleaf-Scrub Woodland	165	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	447/124	Meander Inactive Floodplain Cover Deposit	447	Closed Tall Willow Shrub	221	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	447/236	Meander Inactive Floodplain Cover Deposit	447	Closed Tall Alder-Willow Shrub	221	Riverine Tall Scrub
Riverine Moist Tall Scrub	30041	Riverine	480/224	Headwater Floodplain, Small Watercourse	480	Open Tall Shrub Swamp	236	Riverine Tall Scrub
Riverine Wet Low Scrub	30042	Riverine	437/262	Braided Inactive Floodplain Cover Deposit	437	Open Tall Alder-Willow Shrub	224	Riverine Tall Scrub
Riverine Wet Low Scrub	30042	Riverine	445/262	Meander Active Floodplain Cover Deposit	445	Open Low Willow-Grannold Shrub Bog	262	Riverine Low Scrub
Riverine Wet Low Scrub	30042	Riverine	447/249	Meander Inactive Floodplain Cover Deposit	447	Open Low Willow-Grannold Shrub Bog	249	Riverine Low Scrub</

Appendix A (cont'd). System used for aggregating geomorphic and vegetation classes into ecotype classes, Fort Wainwright, Alaska, 1996.

Ecotype name-1998	Code	Physiography	ITU code	Geomorphic name	Code	Vegetation name	Code	Ecotype name-1996
Upland Moist Broadleaf Forest	70632	Upland	523/165	Upland Retransported Deposits	523	Broadleaf-Scrub Woodland	165	Upland Broadleaf Forest
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12/145	Residual Soil over Weathered Bedrock	12	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12/146	Residual Soil over Weathered Bedrock	12	Closed Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12/154	Residual Soil over Weathered Bedrock	12	Open Paper Birch-Quaking Aspen Forest	154	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	372/145	Upland Loess	372	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	372/146	Upland Loess	372	Closed Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	372/154	Upland Loess	372	Open Paper Birch-Quaking Aspen Forest	154	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	376/145	Upland Loess/Weathered Bedrock	376	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	376/146	Upland Loess/Weathered Bedrock	376	Closed Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	523/145	Upland Loess/Eolian Sand/Floodplain	523	Closed Quaking Aspen Forest	145	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	523/146	Upland Retransported Deposits	523	Closed Quaking Aspen Forest	146	Upland Broadleaf Forest (south-facing)
Upland Moist Broadleaf Forest (south-facing)	70632.1	Upland	12/246	Upland Retransported Deposits	12	Open Paper Birch-Quaking Aspen Forest	246	Upland Broadleaf Forest (south-facing)
Upland Moist Low Scrub	70642	Upland	12/259	Residual Soil over Weathered Bedrock	12	Closed Low Scrub Birch-Ericaceous Shrub	259	Upland Low Scrub
Upland Moist Mixed Forest	70633	Upland	12/171	Residual Soil over Weathered Bedrock	12	Open Spruce-Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	372/171	Upland Loess	372	Closed Spruce-Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	375/171	Upland Loess/Weathered Bedrock	375	Closed Spruce-Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	523/171	Upland Retransported Deposits	523	Open Spruce-Paper Birch Forest	171	Upland Mixed Forest
Upland Moist Mixed Forest	70633	Upland	523/181	Upland Retransported Deposits	523	Closed Spruce-Paper Birch Forest	181	Upland Mixed Forest
Upland Moist Mixed Forest	70633.1	Upland	12/173	Residual Soil over Weathered Bedrock	12	Open Spruce-Paper Birch Forest	173	Upland Mixed Forest
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/173	Upland Loess	372	Closed Spruce-Paper Birch-Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	375/173	Upland Loess	375	Closed Quaking Aspen-Spruce Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	376/173	Upland Loess/Weathered Bedrock	376	Closed Quaking Aspen-Spruce Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	380/173	Upland Loess/Eolian Sand/Floodplain	380	Closed Spruce-Paper Birch-Quaking Aspen Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/173	Eolian Sand Dunes	523	Closed Quaking Aspen-Spruce Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/173	Upland Retransported Deposits	523	Open Quaking Aspen-Spruce Forest	173	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/112	Residual Soil over Weathered Bedrock	12	Closed White Spruce Forest	112	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/114	Residual Soil over Weathered Bedrock	12	Closed Black Spruce Forest	114	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/128	Residual Soil over Weathered Bedrock	12	Open Black Spruce-White Spruce Forest	128	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/129	Residual Soil over Weathered Bedrock	12	Open Black Spruce-White Spruce Forest	129	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/128	Upland Loess	372	Open Black Spruce-White Spruce Forest	128	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/129	Upland Loess	372	Open Black Spruce-White Spruce Forest	129	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	376/114	Upland Loess/Eolian Sand/Floodplain	376	Closed Black Spruce-White Spruce Forest	114	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	380/114	Eolian Sand Dunes	380	Closed Black Spruce-White Spruce Forest	114	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/112	Upland Retransported Deposits	523	Closed White Spruce Forest	112	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/114	Upland Retransported Deposits	523	Closed Black Spruce Forest	114	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/124	Upland Retransported Deposits	523	Open White Spruce Forest	124	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/222	Residual Soil over Weathered Bedrock	12	Closed Tail Alder Shrub	222	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/224	Residual Soil over Weathered Bedrock	12	Closed Tail Alder Shrub	224	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/232	Residual Soil over Weathered Bedrock	12	Open Tail Alder Shrub	232	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/165	Upland Loess	372	Broadleaf-Scrub Woodland	165	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/222	Upland Loess	372	Closed Tail Alder Shrub	222	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/224	Upland Loess	372	Closed Tail Alder-Willow Shrub	224	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	375/224	Upland Loess	375	Closed Tail Alder Shrub	224	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/304	Residual Soil over Weathered Bedrock	12	Closed Tail Alder-Willow Shrub	304	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/304	Upland Loess	372	Midgrass-Shrub	304	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/435	Residual Soil over Weathered Bedrock	12	Slope Drainage Complex	435	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/113	Residual Soil over Weathered Bedrock	12	Closed Black Spruce Forest	113	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	12/125	Residual Soil over Weathered Bedrock	12	Open Black Spruce Forest	125	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/113	Upland Loess	372	Open Black Spruce Forest	113	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	372/125	Upland Loess	372	Open Black Spruce Forest	125	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	375/125	Upland Loess, frozen	375	Open Black Spruce Forest	125	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/113	Upland Retransported Deposits	523	Closed Black Spruce Forest	113	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	523/125	Upland Retransported Deposits	523	Open Black Spruce Forest	125	Upland Mixed Forest (south-facing)
Upland Moist Mixed Forest (south-facing)	70633.1	Upland	911	Upper Perennial River, nonglacial	911	Water (<5% vegetated)	1	River

Appendix B. Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physio- graphy	Plot	Year	Lat Nad27	Long Nad27	Terrain unit	Surf- form	Moist class	Water Depth cm	pH	EC uS/cm	Surf org depth cm	Grav depth cm	Thaw depth	Perma- frost	Veg code	Dominant Species	ITTU code	EcoType
Lowland	P1.01	1994	64.7272	-147.9508	Fpac	Fh	W	nd	nd	nd	19	>174	66	P	125	Picmar/Ledgro/Vacvit-Hylspl	452/125	Lowland Wet Needleleaf Forest
Lowland	P1.06	1994	64.7265	-147.9519	Fpac	Fh	W	0	nd	nd	30	>80	89	P	246	Chacal-Betgla-Ledgro	452/246	Lowland Wet Low Scrub
Lowland	P1.08	1994	64.7258	-147.9530	Obc/Fpac	N	W	0	nd	nd	118	>150	>155	A	343	Carcho-Potpal/Hypasp	874/343	Lowland Fen Meadow
Lowland	P1.13	1994	64.7243	-147.9547	Obc/Fpac	N	W	0	nd	nd	211	>200	>199	A	368	Caracu-Mentri	874/368	Lowland Fen Meadow
Lowland	P1.15	1994	64.7214	-147.9600	Obc/Fpac	nd	nd	nd	nd	nd	130	287	nd	A	343	Myrgal-Carros-Caracu/Sphagnum	874/343	Lowland Fen Meadow
Lowland	P1.24	1994	64.7222	-147.9585	Obp/Fpac	nd	nd	nd	nd	nd	47	>69	69	A	144	Betpap/Calcan-Rosaci	884/144	Lowland Wet Broadleaf Forest
Riverine	P2.05	1994	64.6751	-147.7794	Fmcl	nd	nd	>-128	nd	nd	9	>128	128	A	171	Betpap-Picgla/Salbeb-Rosaci/Equarv	447/171	Riverine Moist Mixed Forest
Lowland	P2.11	1994	64.6756	-147.7779	Fpac	nd	nd	>-62	nd	nd	14	>166	62	P	255	Ledgro-Salbeb-Vacvit/Vacvit	452/246	Lowland Wet Low Scrub
Lowland	P2.17	1994	64.6765	-147.7744	Obc/Fpac	nd	W	0	7.5	nd	23	160	>252	A	236	Alnten-Salarb-Salplan/Caracu-Equifu	874/236	Lowland Scrub Fen
Lowland	P2.23	1994	64.6771	-147.7725	Obc/Fpac	nd	W	-30	7.0	nd	22	>74	74	P	171	Picgla-Betpap/Alnteri/Rosaci-Salbeb/Vacvit-Hylspl	876/171	Lowland Wet Mixed Forest
Lowland	P2.30	1994	64.6778	-147.7706	Obc/Fpac	nd	W	0	7.0	nd	36	>56	56	P	136	Picgla-Betgla/Chacal-Vacvit/Equarv	876/136	Lowland Wet Low Scrub
Lowland	P2.38	1994	64.6789	-147.7675	Obc/Fpac	nd	W	-20	7.0	395	56	>56	56	P	255	Betgla-Myrgal/Calcan	876/246	Lowland Wet Low Scrub
Lowland	P3.08	1994	64.6072	-147.9572	Fpac	terraced	nd	nd	nd	nd	3	15	unfrzn	A	124	Picgla/Salbeb-Ledgro-Vacvit/Vacvit	451/124	Lowland Gravelly Moist Needleleaf Forest
Lowland	P3.12	1994	64.6074	-147.9569	Fpac-n	nd	nd	nd	nd	nd	5	>482	nd	A	113	Picmar/Hylspl	455/113	Lowland Wet Needleleaf Forest
Lowland	P3.25	1994	64.6086	-147.9549	Obc/Fpac	nd	W	-5	nd	nd	50	>50	nd	A	343	Carros/Oxyntic-Sphag	874/343	Lowland Wet Meadow
Lowland	P3.28	1994	64.6090	-147.9543	Fpac	nd	W	-15	nd	nd	24	>49	185	A	246	Betgla-Chacal-Vacvit/Calcan	452/246	Lowland Wet Low Scrub
Lowland	P3.51	1994	64.6097	-147.9532	Fpac	nd	nd	-50	nd	nd	20	>20	frozen	P	171	Betpap-Picmar/Ledgro-Salbeb/Vacvit	452/171	Lowland Wet Mixed Forest
Lowland	P3.74	1994	64.6104	-147.9513	Fpac	Fh/Tp	nd	nd	nd	nd	38	426	unfrzn	A	236	Alnten/Calcan-Potpal	452/236	Lowland Scrub Fen
Lowland	P3.77	1994	64.6110	-147.9513	Fpac	nd	W	-5	nd	nd	11	>180	127	A	144	Betpap/Rosaci-Salbeb/Equarv	452/144	Lowland Wet Broadleaf Forest
Lowland	G10.01	1995	64.6119	-147.9499	Obc/Fpac	Fh	W	-5	nd	nd	73	320	unfrzn	A	343	Oxymic-Sphag	874/343	Lowland Bog Meadow
Upland	G10.02	1995	nd	nd	Elu/Bxw	nd	M	>-49	nd	nd	6	53	>53	U	171	Betpap-Picgla/Alnteri/Rosaci-Calcan	372/171	Upland Moist Mixed Forest
Upland	G10.03	1995	nd	nd	Elu/Bxw	N	M	>-27	nd	nd	7	>27	>49	U	165	Poptre-Betpap/Alnteri	372/165	Upland Moist Tail Scrub
Upland	G10.04	1995	nd	nd	Obc/Fh/Bxw	N	M	>-43	nd	nd	19	>33	>55	U	125	Picmar/Ledgro/Emptnig/Hylspl	372/154	Upland Moist Broadleaf Forest (south-facing)
Upland	G10.05	1995	nd	nd	Obc/Fh/Bxw	Fh	M	>-56	nd	nd	15	>33	>55	U	113	Picmar/Alnteri/Arclat/Hylspl	888/125	Upland Wet Needleleaf Forest
Upland	G10.06	1995	nd	nd	Elu/Bxw	Mu	M	>-65	nd	nd	5	>65	>65	U	146	Poptre-Betpap-Picgla/Lyan	372/146	Upland Wet Broadleaf Forest
Riverine	G10.21	1995	nd	nd	Fmcl	N	M	>-40	nd	nd	5	>275	>275	A	143	Popal-Picgla/Rosaci-Calcan	447/143	Riverine Moist Broadleaf Forest
Lowland	G10.22	1995	nd	nd	Elu	N	M	>-50	nd	nd	2	>204	>204	A	127	Larlar-Picgla/Equarv/Hylspl	371/127	Lowland Wet Broadleaf Forest
Upland	G11.2	1995	nd	nd	Elu/Bxw	Mu	M	>-23	nd	nd	9	23	>23	U	165	Poptre-Betpap/Alnteri	372/165	Upland Moist Tail Scrub
Lacustrine	G12.1	1995	nd	nd	L/Gfoch	nd	M	>-36	nd	nd	2	>36	>36	U	252	Betgla-Salarb-Ledgro-Erivarv	750/252	Upland Tussock Bog
Lowland	G12.2	1995	nd	nd	Gfoch	Fh	M	>-15	nd	nd	28	36	>36	U	112	Picgla/Ledgro-Pofr/Vacvit/Feathmoss	705/112	Lowland Gravelly Moist Needleleaf Forest
Lowland	G12.4	1995	nd	nd	Obc/Gfoch	nd	W	-5	nd	nd	40	75	>85	U	136	Picgla-Larlar-Betpap/Alnten/Ledgro/Calcan	876/136	Lowland Wet Low Scrub
Lowland	G12.5	1995	nd	nd	Fh	Fh/Tp	nd	nd	nd	nd	18	40	>180	A	125	Picmar/Betgla-Ledgro/Carbig/Sphag	876/125	Lowland Wet Needleleaf Forest
Lowland	G12.6	1995	nd	nd	Gfoch	Fh	M	-25	nd	nd	7	20	>90	U	246	Betgla-Ledgro	705/246	Lowland Gravelly Wet Low Scrub
Lowland	G12.7	1995	nd	nd	Gfoch	Fh	M	-30	nd	190	7	40	>40	U	224	Alnten-Salarb/Betgla-Myrgal/Calcan-Caracu	480/224	Riverine Moist Tail Scrub
Lowland	G12.8	1995	nd	nd	Gfoch	Fh	M	-25	nd	nd	16	30	>30	U	125	Picmar/Hylspl	705/125	Lowland Gravelly Moist Needleleaf Forest
Upland	G4.01	1995	nd	nd	Fsu	Fh	M	>-53	nd	nd	25	>25	>25	U	136	Picmar-Larlar/Betgla/Vacvit	503/136	Upland Moist Broadleaf Forest
Upland	G4.02	1995	nd	nd	Ficb/Ffr	Fh	M	>-35	nd	nd	13	>53	>53	U	154	Betpap-Poptre/Alnten/Calcan-Equarv	503/154	Upland Moist Broadleaf Forest
Upland	G4.03	1995	nd	nd	Fsu	Fh	M	>-52	nd	nd	5	>35	>35	U	181	Picgla-Betpap/Rosaci-Calcan	503/181	Upland Moist Mixed Forest
Lowland	G4.04	1995	nd	nd	Ficb/Ffr	Fh	M	>-80	nd	nd	20	>80	>80	U	181	Picmar-Betpap/Salix/Ledgro/Vacvit	505/181	Lowland Wet Mixed Forest
Lowland	G4.05	1995	nd	nd	Obc/Fsl	Mpm	W	-10	nd	nd	>60	>60	>60	U	343	Erioph/Sphag	888/343	Lowland Fen Meadow
Lacustrine	G4.06	1995	nd	nd	Obc/Fsl	N	W	+5	nd	nd	18	>40	>40	P	125	Picmar/Rosaci-Ledgro/Equis	854/340	Lacustrine Fen Meadow
Lowland	G4.07	1995	nd	nd	Obc/Fsl	nd	M	-20	nd	nd	18	>40	>40	P	125	Picmar/Betgla/Erivarv/Vacvit	505/125	Lowland Wet Needleleaf Forest
Lowland	G4.08	1995	nd	nd	Ficb/Ffr	N	W	-45	nd	nd	20	>45	45	P	340	Carros-Caracu	505/340	Lowland Wet Meadow (not mapped)
Lowland	G4.09	1995	nd	nd	Ficb/Ffr	N	W	-45	nd	nd	30	>30	30	P	311	Calcan	452/311	Lowland Moist Meadow
Lowland	G4.10	1995	nd	nd	Fpac	N	M	>-65	nd	nd	0	>65	>65	U	224	Alnten-Salix/Calamagrostis	718/224	Lowland Gravelly Wet Tall Scrub
Lowland	G4.11	1995	nd	nd	Gfoch	nd	M	-50	nd	nd	4	>40	>40	P	136	Picmar-Larlar/Ledgro-Betgla/Sphag	876/136	Lowland Wet Low Scrub
Lowland	G4.12	1995	nd	nd	Obc/Fpac	Fh	M	-55	nd	nd	45	>55	55	P	127	Picmar-Larlar/Vacvit/Equisyl	505/127	Lowland Wet Needleleaf Forest
Lowland	G4.13	1995	nd	nd	Ficb/Ffr	nd	W	-20	nd	nd	5	>54	>54	U	252	Erivarv-Calcan-Betgla-Chacal/Sphag	876/252	Lowland Tussock Bog
Lowland	G4.14	1995	nd	nd	Obc/Fpac	nd	W	+10	nd	nd	70	>70	70	P	113	Picmar/Feathmoss-Sphag	505/113	Lowland Wet Needleleaf Forest
Upland	G4.16	1995	nd	nd	Ficb/Ffr	Fh	M	>-40	nd	nd	20	>40	30	P	304	Elin-Poe-Rosaci	372/304	Upland Rocky Dry Meadow
Upland	G4.18	1995	nd	nd	Elu/Bxw	nd	D	>-50	nd	nd	0	50	>50	A	231	Salala-Salint/Equarv	447/10	Riverine Barrens
Riverine	G5.01	1995	nd	nd	Fmcl	N	M	nd	nd	nd	0	0	>40	U	224	Alnten-Salix/Equarv-Calcan	447/224	Riverine Moist Tail Scrub
Riverine	G5.02	1995	nd	nd	Fpac	N	M	nd	nd	nd	15	>50	50	P	128	Picmar-Picgla/Rosaci-Ledgro/Feathmoss	452/128	Lowland Wet Meadow
Lowland	G5.03	1995	nd	nd	Fmcl	N	M	nd	nd	nd	6	0	unfrzn	A	173	Betpap-Poptre-Picgla/Salarb	372/173	Upland Moist Mixed Forest (south-facing)
Riverine	G5.04	1995	nd	nd	Elu/Bxw	N	D	nd	nd	nd	0	0	>75	U	336	Scital-Equifu/Hipul	854/340	Lacustrine Fen Meadow
Lacustrine	G5.21	1995	nd	nd	Obc/L	N	W	+48	nd	nd	>75	>75	>75	U	262	Calcan-Carros-Myrgal-Salix	854/262	Lacustrine Fen Meadow
Lacustrine	G5.22	1995	nd	nd	Obc/L	Fh	W	+36	6.5	390	>44	>44	>44	U	340	Carros-Equifu	876/340	Lowland Fen Meadow
Lacustrine	G5.23	1995	nd	nd	Obc/L	N	W	+7	6.3	350	10	>20	>20	U	246	Gypul-Carros-Equifu-Galtri	452/246	Lowland Wet Low Scrub
Lowland	G5.24	1995	nd	nd	Obc/Fpac	N	W	+14	6.0	160	27	>27	>27	U	125	Picmar/Salix/Ledgro/Feathmoss	372/125	Upland Wet Broadleaf Forest (south-facing)
Lowland	G5.25	1995	nd	nd	Obc/Fpac	Fh	M	>-30	nd	nd	9	>40	>40	U	145	Poptre-Picgla/Shecan/Linbor	844/368	Lowland Fen Meadow
Lowland	G5.26	1995	nd	nd	Fsu	N	M	>-40	nd	nd	2	>100	>100	A	368	Mentri/Sphag	876/113	Lowland Wet Needleleaf Forest
Upland	G5.27	1995	nd	nd	Obc/Bxw	N	D	>-27	nd	nd	100	>100	>100	P	113	Picmar/Ledgro/Vacvit/Hylspl		
Upland	G5.40	1995	nd	nd	Obc/Fpac	Fh	M	>-40	nd	nd	40	>40	>40	P				

Appendix B (cont'd). Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physio- graphy	Plot	Year	Lat Nad27	Long Nad27	Terrain unit class	Surf- form	Moist class	Water Depth cm	pH	EC uS/cm	Surf org depth	Grav depth (text)	Thaw depth	Perma- frost	Veg code	Dominant Species	ITU code	Ecotype
Lowland	G5.42	1995	nd	nd	Obl/Fpac	N	W	+2	nd	nd	62	>90	>90	A	340	Caros	844/340	Lowland Fen Meadow
Upland	G5.43	1995	nd	nd	Fpac	Fh	M	>-90	nd	nd	5	>125	>125	U	174	Poptre-Picglia/Shecan/Linbor/Hylspl	372/173	Upland Moist Mixed Forest (south-facing)
Lowland	G5.44	1995	nd	nd	Fpac	Fh	M	>-54	nd	nd	12	>54	>54	U	311	Calcan	452/311	Lowland Moist Meadow
Riverine	G5.46	1995	nd	nd	Fmcl	N	W	+5	nd	nd	0	>80	>80	U	340	Caros	447/340	Riverine Wet Meadow
Riverine	G5.47	1995	nd	nd	Fmcl	N	W	-30	nd	nd	0	>83	>83	U	231	Salarb-Salbeb/Myrgal-Vaculi/Calcan	447/224	Riverine Moist Tall Scrub
Riverine	G5.48	1995	nd	nd	Fmcl	N	W	+40	nd	nd	5	>55	>55	U	336	Scival/Hipval	447/336	Riverine Wet Meadow
Lowland	G5.49	1995	nd	nd	Fmcl	N	W	-15	nd	nd	14	>55	>55	U	125	Picmar/Ledgro-Vaculi/Hylspl	452/125	Lowland Wet Needleleaf Forest
Riverine	G5.50	1995	nd	nd	Fmcl	N	W	+5	nd	nd	0	>50	>50	U	340	Caros-Equifu	447/340	Riverine Wet Meadow
Riverine	G5.51	1995	nd	nd	Fmcl	N	W	-30	nd	nd	7	>40	>40	U	165	Beipap-Poplar/Salbeb/Shecan/Equarv	447/165	Riverine Moist Tall Scrub
Riverine	G5.53	1995	nd	nd	Fmcl	N	W	-30	nd	nd	5	>55	>55	U	311	Caros-Calcan	447/311	Lowland Moist Meadow
Lowland	G5.54	1995	nd	nd	Obc/Fpac	N	W	-10	nd	nd	85	>100	>100	A	343	Caracu-Calcan/Sphag	874/343	Lowland Bog Meadow
Lowland	G5.55	1995	nd	nd	Obc/Fpac	N	W	-15	nd	nd	85	>95	>95	A	262	Alnten-Salix/Calcan/Sphag	874/262	Lowland Scrub Fen
Lowland	G5.56	1995	nd	nd	Obc/Fpac	N	W	-44	nd	nd	30	>44	>44	P	181	Picglia-Betpap/Salix/Ledgro/Hylspl	876/181	Lowland Wet Mixed Forest
Riverine	G5.57	1995	nd	nd	Fpac	Tip	M/W	0	nd	nd	19	>48	>48	P	112	Picglia/Rosaci/Calcan/Hylspl	452/112	Lowland Wet Needleleaf Forest
Lowland	G5.58	1995	nd	nd	Fh	N	W	-15	nd	nd	10	>44	>44	U	236	Alnten-Salbeb/Calcan	480/236	Lowland Wet Tall Scrub
Lowland	G5.59	1995	nd	nd	Fpac	N	W	-75	nd	nd	15	>55	>55	U	128	Caracu-Caros-Potpal	452/128	Lowland Wet Meadow (not mapped)
Lowland	G5.60	1995	nd	nd	Fpac	N	W	-25	nd	nd	20	>115	var	U	127	Larlar-Picmar/Ledgro/Vacvit/Hylspl	885/127	Lowland Wet Needleleaf Forest
Lacustrine	G5.62	1995	nd	nd	Obc/L	N	W	-5	nd	nd	75	>85	>85	U	368	Mentri-Poplar-Carex-Equifu	854/368	Lacustrine Fen Meadow
Lacustrine	G5.63	1995	nd	nd	Obc/L	N	W	-5	nd	nd	50	>55	>55	P	136	Larlar-Picmar/Betglia-Salix/Potpal	876/136	Lowland Wet Low Scrub
Lowland	G5.64	1995	nd	nd	Fpac	N	W	>-55	nd	nd	5	>55	>55	P	211	Picmar/Ledgro-Vaculi/Vacvit	452/211	Lowland Wet Needleleaf Forest
Lowland	G5.65	1995	nd	nd	Obc/Fpac	N	W	>-10	nd	nd	5	>60	>60	P	236	Alnten-Salix/Calcan-Caracu-Potpal	452/236	Lowland Wet Needleleaf Forest
Lowland	G5.66	1995	nd	nd	Fpac	N	W	>-38	nd	nd	26	>56	>56	P	125	Picmar-Larlar/Salix/Ledgro/Vacvit-Empnig/Hylspl	452/125	Lowland Wet Needleleaf Forest
Lowland	G5.67	1995	nd	nd	Fpac	N	W	>-10	nd	nd	15	>38	>38	P	165	Beipap-Salbeb-Alnten/Sapp/Ledgro-Vaculi	452/165	Lowland Wet Tall Scrub
Lacustrine	G5.68	1995	nd	nd	Obc/L	N	W	+5	nd	nd	>45	>45	>45	U	340	Caros-Carmag-Myrgal	854/340	Lacustrine Fen Meadow
Lowland	G5.69	1995	nd	nd	Fpac	N	W	>-16	nd	nd	12	>30	>30	U	124	Picglia/Rosaci/Equarv/Hylspl	452/124	Lowland Wet Needleleaf Forest
Lowland	G5.70	1995	nd	nd	Obc/L	N	W	+10	nd	nd	>50	>50	>50	U	368	Mentri-Caracu-Erioph	854/368	Lacustrine Fen Meadow
Lowland	G5.71	1995	nd	nd	Fpac	N	W	>-32	nd	nd	17	>32	>32	U	243	Picmar/Rosaci/Hylspl	452/243	Lowland Wet Needleleaf Forest
Lowland	G5.72	1995	nd	nd	Fpac	N	W	>-10	nd	nd	10	>10	>10	U	136	Larlar-Picmar/Ledgro-Betglia-Vaculi/Aulacom	458/136	Lowland Gravelly Wet Low Scrub
Lowland	G5.73	1995	nd	nd	Fpac	N	W	+12	nd	nd	30	>30	>30	U	340	Caros-Carmag-Myrgal	458/340	Lowland Wet Meadow (not mapped)
Lowland	G5.74	1995	nd	nd	Fpac	N	W	>-58	nd	nd	18	>58	>58	P	224	Alnten	458/224	Lowland Wet Tall Scrub
Upland	G6.05	1995	nd	nd	Fpac	N	W	>-25	nd	nd	13	>25	>25	U	127	Picglia-Larlar/Ledgro-Vaculi/Aulacom-Hylspl	458/127	Upland Gravelly Moist Needleleaf Forest
Upland	P10.02	1995	64.6895	-146.8943	Bxr	N	M	>-46	nd	nd	13	>68	>112	U	112	Picglia/Alncrt/Ledgro/Vacvit/Feathmoss	12/171	Upland Moist Mixed Forest
Upland	P10.03	1995	64.6892	-146.8944	Bxr	N	M	>-50	nd	nd	14	>55	>96	U	171	Beipap-Picglia/Corcan	12/171	Upland Moist Mixed Forest
Upland	P10.04	1995	64.6884	-146.8947	Bxr	N	M	>-55	nd	nd	11	>55	>55	U	171	Picglia-Betpap/Alncrt/Corcan	12/171	Upland Moist Mixed Forest
Upland	P10.05	1995	64.6878	-146.8948	Bxr	N	M	>-40	nd	nd	12	>63	>63	U	171	Beipap/Picglia/Alncrt/Vacvit	12/171	Upland Moist Mixed Forest
Upland	P10.06	1995	64.6865	-146.8951	Bxr	N	M	>-70	nd	nd	3	>45	>73	U	144	Beipap/Picglia/Coca	12/144	Upland Moist Broadleaf Forest
Upland	P10.07	1995	64.6854	-146.8953	Bxr	Mu	M	>-45	nd	nd	3	>45	>69	U	144	Beipap/Calcan/Coca	12/144	Upland Moist Broadleaf Forest
Upland	P10.08	1995	64.6838	-146.8955	Bxr	Mu	M	>-48	nd	nd	10	>48	>80	U	144	Beipap/Alncrt/Rosaci-Calcan	12/144	Upland Moist Broadleaf Forest
Riverine	P10.09	1995	64.6835	-146.8970	Fh	Mu	M	>-53	nd	nd	6	>60	>60	U	181	Beipap-Picglia/Alncrt/Rosaci-Calcan	480/181	Riverine Moist Mixed Forest
Lowland	P11.01	1995	64.4214	-148.0174	Obc/Gfob	Mus	W	+15	nd	nd	75	>205	>240	A	262	Alnten-Sapp	843/262	Lowland Scrub Fen
Lowland	P11.02	1995	64.4215	-148.0170	Obc/Gfob	Fh	W	0	nd	nd	40	>40	>40	U	236	Beipap/Sapp-Alnten/Chacal/Eriang/Calcan	835/236	Lowland Wet Needleleaf Forest
Lowland	P11.03	1995	64.4216	-148.0162	Gfob	N	W	-45	nd	nd	9	>98	>98	U	112	Picglia/Salix/Vacvit/Hylspl	715/112	Lowland Wet Needleleaf Forest
Upland	P11.04	1995	64.4217	-148.0158	Es/Gfob	N	N	>-70	nd	nd	1	>70	>70	P	128	Picmar-Picglia/Shecan/Hylspl-Stereocaulon	380/114	Upland Moist Mixed Forest
Upland	P11.05	1995	64.4219	-148.0148	Es/Gfob	N	D	-210	nd	nd	2	>365	>375	A	182	Picglia-Poptre/Alncrt/Shecan/Vacvit-Anuu	380/182	Upland Moist Mixed Forest (south-facing)
Lowland	P11.06	1995	64.4221	-148.0142	Gfob	N	M	-65	nd	nd	2	>282	>292	A	182	Picglia-Picmar-Poptre/Sagl/Ledgro-Shecan/Hylspl	715/182	Lowland Wet Mixed Forest
Lowland	P11.07	1995	64.4223	-148.0135	Gfob	N	M	-23	nd	nd	16	>82	>82	P	125	Picmar/Ledgro-Vaculi/Vacvit/Hylspl	715/125	Lowland Wet Needleleaf Forest
Lowland	P11.08	1995	64.4225	-148.0122	Obc/Gfob	N	M	+17	nd	nd	53	>176	>186	A	262	Beipap-Salix-Alncrt/Caracu-Calcan-Potpal	843/262	Lowland Scrub Fen
Lowland	P11.10	1995	64.4225	-148.0106	Gfob	N	W	-20	nd	nd	18	>58	>58	P	115	Larlar-Picglia/Ledgro-Betglia-Potr	715/115	Lowland Wet Needleleaf Forest
Lowland	P11.13	1995	64.4225	-148.0094	Gfob	N	W	-15	nd	nd	15	>88	>88	P	127	Picglia-Larlar-Betpap/Ledgro-Betglia-Chacal	715/127	Lowland Wet Needleleaf Forest
Lowland	P11.15	1995	64.4227	-148.0085	Obc/Gfob	N	W	0	nd	nd	28	>95	>140	A	262	Chacal-Caracu	843/262	Lowland Scrub Fen
Lowland	P11.16	1995	64.4227	-148.0071	Gfob	N	W	-40	nd	nd	60	>58	>58	P	113	Larlar/Picmar/Ledgro/Vacvit/Hylspl	715/113	Lowland Wet Needleleaf Forest
Riverine	P4.0	1995	64.3891	-147.2942	911	N	D	+11	nd	nd	0	>35	>35	A	0		911/0	Upper Perennial River
Riverine	P4.12	1995	64.3897	-147.2932	Fmcl	N	W	>-100	nd	nd	8	>42	>61	A	124	Picglia/Rosaci/Equarv/Hylspl	447/124	Riverine Moist Needleleaf Forest
Riverine	P4.25	1995	64.3900	-147.2926	Fmcl	N	W	+3	nd	nd	1	>230	>230	A	236	Alnten-Salarb/Calcan-Potpal	447/236	Riverine Moist Tall Scrub
Lowland	P4.31	1995	64.3904	-147.2920	Elu/Ffcbt	N	D	>-80	nd	nd	11	>67	>366	A	125	Picmar/Ledgro/Vacvit-Geolvi	371/125	Lowland Wet Needleleaf Forest
Lowland	P4.34	1995	64.3907	-147.2916	Elu/Ffcbt	N	M	-19	nd	nd	11	>35	>35	P	113	Picmar/Ledgro/Vacvit/Hylspl	371/113	Lowland Wet Needleleaf Forest
Lowland	P4.39	1995	64.3914	-147.2904	Obc/Ffcbt	N	M	-22	nd	nd	31	>35	>35	P	136	Picmar/Betglia-Ledgro/Erivag	876/136	Lowland Wet Low Scrub
Upland	P4.46	1995	64.3924	-147.2887	Elu/Ffcbt	N	D	>-180	nd	nd	15	>360	>366	A	113	Picmar/Ledgro/Vacvit/Hylspl	372/113	Upland Wet Needleleaf Forest
Upland	P4.53	1995	64.3937	-147.2865	Elu/Ffcbt	N	D	>-120	nd	nd	5	>281	>366	A	147	Poptre-Potpal-Betpap/Ledgro	372/146	Upland Moist Broadleaf Forest (south-facing)
Lowland	P4.57	1995	64.3944	-147.2855	Elu/Ffcbt	N	D	>-61	nd	nd	17	>61	>61	U	252	Picmar/Salarb/Ledgro/Hylspl	371/252	Lowland Wet Needleleaf Forest
Lowland	P4.64	1995	64.3951	-147.2842	Obc/Ffcbt	N	D	>-41	nd	nd	0	>41	>41	P	252	Betglia/Erivag-Calcan/Plesch	876/252	Lowland Tussock Bog
Upland	P5.01	1995	64.4677	-148.1606	Bxr	N	D	>-28	nd	nd	0	>28	>28	A	304	Elin-Rosaci/Artr/Sesi	12/304	Upland Rocky Dry Meadow
Upland	P5.02	1995	64.4670	-148.1598	Fsu	N	D	>-84	nd	nd	1	>84	>84	A	124	Picglia/Vacvit-Geolvi/Hylspl	523/124	Upland Moist Needleleaf Forest
Lowland	P5.03	1995	64.4663	-148.1592	Fsl	N	D	>-80	nd	nd	1	>53	>80	A	114	Picglia-Picmar/Linbor-Vacvit/Hylspl	520/114	Upland Wet Needleleaf Forest
Lowland	P5.04	1995	64.4656	-148.1585	Obc/Fpac	N	W	>-80	nd	nd	67	>155	>175	A	136	Larlar-Picmar/Betglia-Chacal/Eriang-Calcan/Sphag	874/136	Lowland Wet Low Scrub

Appendix B (cont'd). Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physiography	Plot	Year	Lat	Long	Terrain unit class	Surf. form	Moist class	Water Depth cm	pH	EC uS/cm	Surf depth (text)	Gro depth (text)	Thaw depth	Permafrost	Veg code	Dominant Species	ITU code	Ecotype
Lowland	P5.05	1995	64.4648	-148.1576	Fpac	Fh	M	nd	nd	nd	33	>33	33	P	125	Picmar-Larlar/Ledgro/Equyul/Vacvit/Sphag	452/125	Lowland Wet Needleleaf Forest
Lowland	P5.06	1995	64.4646	-148.1573	Fpac	Mu	M	nd	nd	nd	9	>75	75	P	124	Picgla-Betpap/Salix/Equyul/Vacvit	452/124	Lowland Wet Needleleaf Forest
Lowland	P5.07	1995	64.4644	-148.1570	Obc/Fpac	Ip	W	+43	6.9	200	0	>110	300	A	368	Menri-Typlat	874/368	Lowland Fen Meadow
Lowland	P5.08	1995	64.4633	-148.1559	Obpp/Fpac	Mu	M	nd	nd	nd	>64	>64	64	P	144	Betpap-Picgla/Ledgro/Vacvit	884/144	Lowland Wet Broadleaf Forest
Lowland	P5.09a	1995	64.4628	-148.1553	Obc/Fpac	Mu	W	+100	7.2	180	nd	>110	83	P	181	Betpap-Picgla/Betpap-Ledgro/Vacvit	884/181	Lowland Wet Mixed Forest
Lowland	P5.09b	1995	64.4627	-148.1553	Obc/Fpac	Ip	W	>+80	nd	nd	290	>570	>570	A	366	Calpal-Typlat-Caracu	874/471	Lowland Fen Meadow
Lowland	P5.10	1995	64.4625	-148.1550	Obc/Fpac	N	W	-16	5.7	70	nd	nd	nd	U	255	Popal-Equyul/Sphag	874/368	Lowland Fen Meadow
Lowland	P5.11	1995	64.4616	-148.1540	Obc/Fpac	Fh	D	>-33	nd	nd	5	33	>33	U	145	Betpap-Picgla/Ledgro/Equyul-Calpal/Sphag	874/246	Lowland Wet Low Scrub
Upland	P5.12	1995	64.4682	-148.1612	Bxr	N	D	>-160	nd	nd	0	>160	>160	A	173	Popal-Equyul/Ledgro/Vacvit-Linbor/Hylspl	12/145	Upland Moist Broadleaf Forest (south-facing)
Upland	P5.13	1995	64.4691	-148.1618	Fsu	N	D	>-80	nd	nd	7	>80	>80	P	171	Popal-Equyul-Ledgro/Vacvit-Linbor/Hylspl	523/173	Upland Moist Broadleaf Forest (south-facing)
Lowland	P5.14	1995	64.4698	-148.1626	Fsl	Mu	W	-14	5.2	70	28	>40	>40	P	171	Picgla-Betpap/Vacvit/Hylspl	520/171	Lowland Wet Mixed Forest
Lacustrine	P5.15	1995	64.4704	-148.1633	Olsh/L	Fh	W	-5	4.8	70	35	>440	>440	A	342	Caracu-Chacal	854/339	Lacustrine Fen Meadow
Lacustrine	P5.16	1995	64.4713	-148.1633	Olsh/L	N	W	+30	6.6	30	0	>244	>244	A	340	Caracu-Chacal	854/339	Lacustrine Fen Meadow
Lacustrine	P5.17a	1995	64.4719	-148.1644	L	N	W	+30	6.6	30	0	>244	>244	A	340	Caracu-Chacal	854/339	Lacustrine Fen Meadow
Lacustrine	P5.17b	1995	64.4723	-148.1640	L	N	W	+30	6.6	30	0	>244	>244	A	340	Caracu-Chacal	854/339	Lacustrine Fen Meadow
Lacustrine	P5.18	1995	64.4729	-148.1638	Obs/F	Fh	M/W	nd	5.2	30	108	>108	>108	U	255	Chacal-Caracu-Eru-Caracu-Calcan	750/386	Lakes or Ponds
Lacustrine	P5.19	1995	64.4732	-148.1638	Obs/F	Fh	M	nd	nd	nd	11	>32	32	U	211	Picmar/Betpala-Ledgro/Erivag/Feathmoss	885/246	Lowland Wet Low Scrub
Lowland	P5.20	1995	64.4738	-148.1637	Fpac	N	M	>-180	nd	nd	5	>180	>180	A	311	Calcan-Eriang	452/311	Lowland Wet Meadow
Lowland	P5.21	1995	64.4745	-148.1632	Fpac-n	N	M	nd	nd	nd	14	>180	>180	A	114	Picmar-Picgla/Poplre/Ledgro/Vacvit	455/114	Lowland Wet Needleleaf Forest
Lowland	P5.22	1995	64.4755	-148.1624	Fpac	N	D	nd	nd	nd	2	13	>100	A	182	Picgla-Poplre-Picmar/Feathmoss-Geoliv/Vacvit/Crust Lichen	451/182	Lowland Gravelly Moist Mixed Forest
Lowland	P5.23	1995	64.4758	-148.1614	Fpac	N	M	nd	nd	nd	10	>50	50	P	113	Picmar-Poplre/Saal/Vacvit/Hylspl	451/113	Lowland Gravelly Moist Needleleaf Forest
Riverine	P6.01	1995	64.5564	-147.0954	Fbcd	N	M	>-95	6.3	831	6	76	>95	A	184	Picgla-Poplre/Alnten/Coca	437/175	Riverine Moist Mixed Forest
Riverine	P6.02	1995	64.5562	-147.0981	Fbcd	N	M	-76	nd	nd	20	>20	>20	A	224	Alnten/Equyul-Coca-Egva	435/224	Riverine Moist Tall Scrub
Riverine	P6.03	1995	64.5561	-147.1002	Fbcd	N	M	>-37	nd	nd	6	>37	37	P	224	Alnten-Salix/Ledgro/Vacvit/Feathmoss	437/224	Riverine Moist Needleleaf Forest
Lowland	P6.04	1995	64.5559	-147.1002	Fbcd	Fh	M	>-30	nd	nd	10	>30	30	P	125	Picmar/Betpala-Chacal/Vacvit/Hylspl-Aulacom	452/125	Lowland Wet Needleleaf Forest
Lowland	P6.05	1995	64.5557	-147.1042	Fpac	Fh	M	>-45	nd	nd	6	>45	45	P	115	Picmar-Larlar/Salix/Betpala-Ledgro/Vacvit/Hylspl	452/115	Lowland Wet Needleleaf Forest
Lowland	P6.06	1995	64.5556	-147.1067	Fpac	N	M	>-94	nd	nd	7	>94	94	P	115	Picmar-Larlar/Salix/Betpala-Ledgro/Vacvit/Hylspl	452/115	Lowland Wet Needleleaf Forest
Lowland	P6.07	1995	64.5554	-147.1091	Fpac	N	M	>-10	6.1	123	25	112	>112	U	181	Betpala-Mygal-Erivar-Arclat	456/181	Lowland Tussock Bog
Lowland	P6.08	1995	64.5553	-147.1118	Obc/Fpac	N	W	+10	6.5	98	4	22	>22	U	251	Betpala-Larlar-Betpala-Alnten/Ledgro/Vacvit	458/251	Lowland Gravelly Moist Mixed Forest
Upland	P7.01	1995	64.5551	-147.1142	Fpa-g	Fh	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.02	1995	64.5551	-147.1142	Fpa-g	Mu	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.03	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.04	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.05	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.06	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.07	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.08	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.09	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.10	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.11	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.12	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.13	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.14	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.15	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.16	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.17	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.18	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.19	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.20	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.21	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.22	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.23	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.24	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.25	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.26	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.27	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.28	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.29	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.30	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.31	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.32	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.33	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.34	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.35	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.36	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.37	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.38	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.39	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.40	1995	64.5551	-147.1142	Fpa-g	N	M	>-43	nd	nd	10	>50	>50	A	144	Betpala-Rosac-Vied/Calcan/Equyul	523/144	Upland Moist Broadleaf Forest
Upland	P7.41	1995	64.5551	-147.1142	Fpa-g	N	M	>-43										



Appendix B. (cont'd). Data file listing of environmental characteristics of survey plots, Ft. Wainwright, Alaska, 1998.

Physio- graphy	Plot	Year	Lat Nad27	Long Nad27	Terrain unit class	Surf. form	Moist class	Water Depth cm	pH	EC uS/cm	Surf org depth	Grav dep (text)	Thaw depth	Perma- frost	Veg code	Dominant Species	ITU code	Eotype
Lowland	LLS3	1998	64.7306	-147.0221	Obf	N	M/W	-14	4.2	60	42	>76	42	P	252	Erivag-Leddec-Bethan/Rubcha-Vacvit	876/252	Lowland Tussock Bog
Lowland	LN1	1998	64.7787	-147.0047	Ell	Fh	M	-50	4.8	20	13	>130	68	P	125	Picmar/Ledgro-Vacvit/Vacvit/Plesch-Hylspl	371/125	Lowland Wet Needleleaf Forest
Lowland	LN2	1998	64.6514	-146.9905	Fpac	N	M	-41	4.3	110	12	np	50	P	125	Picmar/Ledgro/Vacvit/Hylspl-Plesch	452/125	Lowland Wet Needleleaf Forest
Lowland	LN3	1998	64.7182	-147.1019	Ell	N	M	-48	6.3	60	15	>112	48	P	211	Picmar/Leddec/Vacvit/Mosses	371/211	Lowland Wet Needleleaf Forest
Lowland	LNC01	1998	64.7646	-147.0888	Ell	N	M	-36	6.2	220	9	>86	36	P	125	Picmar/Ledgro/Vacvit/Hylspl-Lichens	371/125	Lowland Wet Needleleaf Forest
Lowland	LNC03	1998	64.7590	-147.0666	Ell	N	M/W	-15	7.1	370	14	>41	54	P	125	Picmar/Ledgro/Vacvit/Hylspl	371/125	Lowland Wet Needleleaf Forest
Lowland	LSC01	1998	64.7008	-147.0360	Obf	N	M/W	-24	5.4	80	33	>33	39	P	263	Myrgal/Carlum-Andopol/Sphagnum	876/263	Lowland Scrub Fen
Riverine	RB1	1998	64.8452	-146.9699	Fmci	N	D	>-250	5.8	30	9	>250	>250	A	143	Popbal/Rosaci-Calcan-Rubida/Equarv	447/143	Riverine Moist Broadleaf Forest
Riverine	RB2	1998	64.7131	-147.1117	Fmci	N	M	>-50	5.2	170	2	>50	nd	U	144	Betpap/Rosaci-Calcan-Rubida/Equarv	447/144	Riverine Moist Broadleaf Forest
Riverine	RN1	1998	64.8415	-146.9650	Fmci	N	D	>-41	4.5	30	5	>28	>41	U	124	Picglia/Alncr/Linbor/Hylspl-Plesch-Rhytri	447/124	Riverine Moist Needleleaf Forest
Riverine	RN2	1998	64.7156	-147.1131	Fmci	N	M	>-50	5.7	90	2	>120	>120	A	112	Picglia/Alncr/Linbor/Hylspl-Plesch-Rhytri	447/112	Riverine Moist Needleleaf Forest
Riverine	RTS1	1998	64.8452	-146.9707	Fmci	N	D	>-200	6.7	30	0	>130	>130	A	221	Salas-Salala-Salarb/Equarv	445/221	Riverine Moist Tail Scrub
Riverine	RTS2	1998	64.7128	-147.1125	Fmci	N	M	>-68	6.0	170	2	>68	>68	A	221	Salas-Salala-Salarb/Equarv	445/221	Riverine Moist Tail Scrub
Lowland	SB1	1998	64.7752	-147.0183	Obc	Tc	W	-10	nd	nd	40	nd	>150	U	343	Cararu-Andopol/Sphag	874/343	Riverine Moist Tail Scrub
Upland	UBN1	1998	64.6612	-146.7187	Elu	N	M	>-43	4.4	20	7	>43	>43	U	144	Betpap-Picmar/Calcan/Hylspl-Plesch-Polyt	372/144	Upland Bog Meadow
Upland	UBN2	1998	64.5616	-146.7654	Bxr	N	D	>-56	4.7	10	5	>50	>56	U	144	Betpap/Alncr	12/144	Upland Moist Broadleaf Forest
Upland	UBN3	1998	64.6002	-146.9249	Bxr	N	D	>-35	4.5	30	10	>33	>33	U	144	Betpap/Alncr/Calcan/Hylspl	12/144	Upland Moist Broadleaf Forest
Upland	UBNC01	1998	64.6304	-146.6486	Elu	N	D	>-39	4.6	10	10	>39	>43	A	144	Betpap-Picmar/Alncr/Calcan/Lycann	372/144	Upland Moist Broadleaf Forest
Upland	UBNC02	1998	64.6954	-147.0095	Elu	N	D	>-48	4.7	40	6	>200	>200	A	144	Betpap/Linbor	372/146	Upland Moist Broadleaf Forest (south-facing)
Upland	UBS1	1998	64.6744	-146.7548	Elu	N	M	>-82	5.5	10	6	>50	>82	U	174	Poptr-Picmar/Lyccomp/Plesch-Polytrichum	372/174	Upland Moist Mixed Forest (south-facing)
Upland	UBS2	1998	64.5604	-146.7628	Elu/Bxr	N	D	>-40	1.8	10	1	>19	>52	U	151	Poptr-Picmar/Alncr/Calcan	372/154	Upland Moist Broadleaf Forest (south-facing)
Upland	UBS3	1998	64.6584	-146.9140	Bxr	N	D	>-115	5.2	0	5	>5	>115	A	144	Betpap/Alncr/Calcan	12/146	Upland Moist Broadleaf Forest (south-facing)
Upland	UBSC01	1998	64.5837	-146.7287	Bxr	N	M	>-35	5.1	10	4	>8	>60	U	144	Betpap/Alncr/Calcan	12/146	Upland Moist Broadleaf Forest (south-facing)
Upland	UBSC03	1998	64.6651	-146.8764	Elu	N	M	>-60	4.8	10	2	>55	>60	U	145	Poptr-Betpap/Lyccann/Hylspl	372/145	Upland Moist Broadleaf Forest (south-facing)
Upland	UNN1	1998	64.6592	-146.7131	Elx	N	W	>-76	4.6	0	13	>33	>76	P	125	Picmar/Vacvit/Feathermoss-Sphagnum	373/125	Upland Wet Needleleaf Forest
Upland	UNN2	1998	64.5646	-146.9193	Bxr	Fh	M	>-31	3.9	80	28	>31	>100	U	125	Picmar/Ledgro/Hylspl-Sphagnum	12/125	Upland Wet Needleleaf Forest
Upland	UNN3	1998	64.6600	-146.7627	Bxr	Fh	M	>-58	4.4	40	26	>32	>58	U	125	Picmar/Ledgro/Hylspl-Sphagnum	12/125	Upland Wet Needleleaf Forest
Upland	UNNC01	1998	64.6736	-146.7637	Elu	N	D	>-40	5.6	0	10	>10	>130	A	125	Picmar/Ledgro/Emprng/Plesch	372/125	Upland Wet Needleleaf Forest
Upland	UNNC03	1998	64.6835	-146.8752	Bxr	N	M	>-16	3.0	240	16	>12	>16	U	113	Picmar/Ledgro/Emprng/Plesch	12/113	Upland Wet Needleleaf Forest
Upland	UNN51	1998	64.6592	-146.7177	Elu	N	M	>-72	5.2	0	14	>64	>72	U	129	Picmar/Ledgro/Vacvit/Hylspl	372/129	Upland Moist Needleleaf Forest
Upland	UNN52	1998	64.5626	-146.7609	Bxr	Fh	M	>-93	5.4	10	14	>28	>93	U	181	Picmar/Betpap/Alncr/Hylspl-Plesch	12/181	Upland Moist Mixed Forest
Upland	UNN53	1998	64.6586	-146.9266	Bxr	N	D	>-83	4.2	50	14	>14	>83	A	129	Picmar/Hylspl-Plesch	12/129	Upland Moist Needleleaf Forest
Upland	UNSC01	1998	64.5960	-146.7651	Elu	N	D	>-33	4.3	20	8	>13	>60	U	125	Picmar/Hylspl	12/125	Upland Wet Needleleaf Forest
Upland	UNSC02	1998	64.5704	-146.7486	Elu	N	M	>-53	4.0	20	19	>40	>53	U	125	Picmar/Hylspl-Plesch	12/125	Upland Wet Needleleaf Forest
Upland	UTSN1	1998	64.6434	-146.6941	Bxr	N	D	>-121	5.4	0	0	>0	>122	A	232	Alncr/Calcan/Polytrichum-Plesch	372/129	Upland Moist Needleleaf Forest
Upland	UTSN2	1998	64.5905	-146.7251	Elu/Bxr	N	D	>-94	4.8	30	1	>21	>94	A	224	Salco-Alncr/Calcan-Epiang	12/232	Upland Moist Tail Scrub
Upland	UTSN3	1998	64.6322	-146.5990	Elu	N	M	>-153	4.5	50	0	>62	>153	P	222	Alncr/Calcan	372/224	Upland Moist Tail Scrub
Upland	UTSS1	1998	64.6719	-146.7487	Elu/Bxw	N	D	>-39	5.0	10	0	>1	>39	U	222	Alncr/Calcan/Polytrichum	372/222	Upland Moist Tail Scrub
Upland	UTSS2	1998	64.5853	-146.7403	Bxr	N	D	>-30	4.9	10	1	>1	>51	A	222	Alncr/Calcan-Epiang	12/222	Upland Moist Tail Scrub
Upland	UTSS3	1998	64.6336	-146.5970	Elu	N	M	>-57	4.8	10	2	>42	>57	U	232	Alncr/Calcan-Epiang	372/232	Upland Moist Tail Scrub



## APPENDIX C. PLANT INVENTORY.

**Table C1. Checklist of collected vascular plants arranged by family from Fort Wainwright Military Installation, Alaska, 1995 (from Racine et al. 1997). Nomenclature follows that used by the University of Alaska Museum.**

Adiantaceae	PETASITES SAGITTATUS (Banks) A. Gray
CRYPTOGRAMMA STELLERI (S. Gmelin) Prantl	RUBECKIA HIRTA L.
Adoxaceae	SAUSSUREA ANGUSTIFOLIA (Willd.) DC.
ADOXA MOSCHATELLINA L.	SENECIO ATROPURPUREUS (Ledeb.) B. Fedtsch.
Alismataceae	SENECIO CONGESTUS (R. Br.) DC.
ALISMA TRIVIALE Pursh	SENECIO LUGENS Richardson
SAGITTARIA CUNEATA E. Sheldon	SENECIO PAUCIFLORUS Pursh
Apiaceae	SENECIO TUNDRICOLA Tolm.
CICUTA BULBIFERA L.	SENECIO VULGARIS L.
CICUTA VIROSA L.	SOLIDAGO CANADENSIS L.
CNIDIUM CNIDIIFOLIUM (Turcz.) Schischkin	SOLIDAGO DECUMBENS E. Greene
PODISTERA MACOUNII (J. Coulter & Rose) Mathias & Constance	SOLIDAGO MULTIRADIATA Aiton
SIUM SUAVE Walter	SONCHUS ARVENSIS L.
Apocynaceae	SONCHUS ASPER (L.) Hill
APOCYNUM ANDROSAEMIFOLIUM L.	TARAXACUM CERATOPHORUM (Ledeb.) DC.
Araceae	TARAXACUM OFFICINALE G. Weber
CALLA PALUSTRIS L.	TRIPLEUROSPERMUM INODORUM (L.) Schultz-Bip.
Aspleniaceae	Balsaminaceae
ATHYRIUM FILIX-FEMINA (L.) Roth	IMPATIENS NOLI-TANGERE L.
CYSTOPTERIS FRAGILIS (L.) Bernh.	Betulaceae
DRYOPTERIS FRAGRANS (L.) Schott	ALNUS TENUIFOLIA Nutt.
GYMNOCARPIUM DRYOPTERIS (L.) Newman	ALNUS VIRIDIS Villar ssp. CRISPA (Aiton) A. Loeve & D. Loeve
GYMNOCARPIUM ROBERTIANUM (Hoffm.) Newman	BETULA GLANDULOSA Michaux
WOODSIA ILVENSIS (L.) R. Br.	BETULA HYBRIDS
Asteraceae	BETULA NANA L.
ACHILLEA BOREALIS Bong.	BETULA PAPYRIFERA Marshall
ACHILLEA MILLEFOLIUM L.	Boraginaceae
ACHILLEA SIBIRICA Ledeb.	LAPPULA MYOSOTIS Moench
ANTENNARIA FRIESIANA (Trautv.) Ekman	MERTENSIA PANICULATA (Aiton) G. Don
ANTENNARIA PULCHERRIMA (Hook.) E. Greene	PLAGIOBOTHRYIS COGNATUS (E. Greene) I. M. Johnston
ANTENNARIA ROSEA (D. C. Eaton) E. Greene	Brassicaceae
ANTHEMIS COTULA L.	ARABIS DIVARICARPA Nelson
ARNICA ALPINA (L.) Olin ssp. ATTENUATA (E. Greene) Maguire	ARABIS HIRSUTA (L.) Scop.
ARNICA ANGUSTIFOLIA M. Vahl	ARABIS HOLBOELLII Hornem.
ARNICA GRISCOMII Fern. ssp. FRIGIDA (C. Meyer ex Iljin) S. J. Wolf	ARABIS LYRATA L.
ARTEMISIA ALASKANA Rydb.	BARBAREA ORTHOCERAS Ledeb.
ARTEMISIA ARCTICA Less.	BRASSICA RAPA L.
ARTEMISIA FRIGIDA Willd.	CASSIA BURSA-PASTORIS (L.) Medikus
ARTEMISIA FURCATA M. Bieb.	CARDAMINE PRATENSIS L. ssp. ANGUSTIFOLIA (Hook.) O. E. Schulz
ARTEMISIA LACINIATA Willd.	DESCURAINIA SOPHIA (L.) Prantl
ARTEMISIA TILESII Ledeb. ssp. ELATIOR (Torr. & A. Gray) Hulten	DESCURAINIA SOPHIOIDES (Fischer) O. Schulz
ASTER JUNCIFORMIS Rydb.	DRABA FLADNIZENSIS Wulfen
ASTER SIBIRICUS L.	DRABA GLABELLA Pursh
BIDENS CERNUA L.	DRABA NEMOROSA L.
CHRYSANTHEMUM LEUCANTHEMUM L.	ERYSIMUM CHEIRANTHOIDES L. ssp. CHEIRANTHOIDES
CIRSIIUM ARVENSE (L.) Scop.	ERYSIMUM INCONSPICUUM (S. Watson) Macmillan
CONYZA CANADENSIS (L.) Cronq.	HALIMOLOBUS MOLLIS (Hook.) Rollins
CREPIS ELEGANS Hook.	HESPERIS MATRONALIS L.
CREPIS TECTORUM L.	LEPIDIUM DENSIFLORUM Schrader
ERIGERON ACRIS L.	LEPIDIUM RUDERALE L.
ERIGERON CAESPITOSUS Nutt.	PARRYA NUDICAULIS (L.) Regel
ERIGERON COMPOSITUS Pursh	RORIPPA BARBAREAEFOLIA (DC.) Kitigawa
ERIGERON ELATUS E. Greene	RORIPPA CURVISILIQUA (Hook.) Besser
ERIGERON GLABELLUS Nutt.	RORIPPA PALUSTRIS (L.) Besser ssp. HISPIDA (Desv.) Jonsell
ERIGERON LONCHOPHYLLUS Hook.	RORIPPA PALUSTRIS (L.) Besser ssp. PALUSTRIS
GAILLARDIA PULCHELLA Foug.	THLASPI ARVENSE L.
GNAPHALIUM ULIGINOSUM L.	Callitrichaceae
MATRICARIA MATRICARIOIDES (Less.) Porter	CALLITRICHE VERNA L. emend. Kutz.
PETASITES FRIGIDUS (L.) Franchet	Campanulaceae
PETASITES NIVALIS E. Greene	CAMPANULA LASIOCARPA Cham.
	CAMPANULA UNIFLORA L.
	Caprifoliaceae
	LINNAEA BOREALIS L.

**Table C1 (cont'd). Checklist of collected vascular plants arranged by family from Fort Wainwright Military Installation, Alaska, 1995 (from Racine et al. 1997). Nomenclature follows that used by the University of Alaska Museum.**

VIBURNUM EDULE (Michaux) Raf.	CAREX ROSTRATA Stokes
Caryophyllaceae	CAREX ROTUNDATA Wahlenb.
DIANTHUS BARBATUS L.	CAREX RUPESTRIS All.
GASTROLYCHNIS AFFINIS (Vahl) Tolm. & Kozhanch.	CAREX SAXATILIS L.
GASTROLYCHNIS OSTENFELDII (A. Pors.) V. V. Petrovsky	CAREX SUPINA Willd. ssp. SPANIOCARPA (Steudel) Hulten
MINUARTIA ARCTICA (Steven) Asch. & Graebner	CAREX TENUIFLORA Wahlenb.
MINUARTIA YUKONENSIS Hulten	CAREX UTRICULATA F. Boott
MOEHRINGIA LATERIFLORA (L.) Fenzl	CAREX VAGINATA Tausch
SILENE WILLIAMSII Britton	ELEOCHARIS ACICULARIS (L.) Roemer & Schultes
SPERGULARIA RUBRA (L.) J. S. Presl & C. Presl	ELEOCHARIS PALUSTRIS (L.) Roemer & Schultes
STELLARIA BOREALIS Bigelow ssp. BOREALIS	ERIOPHORUM ANGUSTIFOLIUM Honck. ssp.
STELLARIA CALYCANTHA (Ledeb.) Bong.	SCABRIUSCULUM Hulten
STELLARIA CRASSIFOLIA Ehrh.	ERIOPHORUM GRACILE Koch
STELLARIA LAETA Richardson	ERIOPHORUM RUSSEOLUM Fries
STELLARIA LONGIFOLIA Muhlenb. ex Willd.	ERIOPHORUM SCHEUCHZERI Hoppe
STELLARIA LONGIPES Goldie	ERIOPHORUM VAGINATUM L.
STELLARIA MEDIA (L.) Villars	KOBRESIA SIMPLICIUSCULA (Wahlenb.) Mackenzie
WILHELMSIA PHYSODES (Fischer) Mcneill	SCIRPUS MICROCARPUS C. Presl
Ceratophyllaceae	SCIRPUS VALIDUS M. Vahl
CERATOPHYLLUM DEMERSUM L.	TRICHOPHORUM ALPINUM (L.) Pers.
Chenopodiaceae	Diapensiaceae
CHENOPODIUM ALBUM L.	DIAPENSIA LAPPONICA L. ssp. OBOVATA (F. Schmidt) Hulten
CHENOPODIUM CAPITATUM (L.) Asch.	Droseraceae
CHENOPODIUM HYBRIDUM L.	DROSERANGLICA Hudson
Cornaceae	DROSERAROTUNDIFOLIA L.
CORNUS CANADENSIS L.	Elaeagnaceae
CORNUS CANADENSIS_X_SUECICA L.	SHEPHERDIA CANADENSIS (L.) Nutt.
SWIDA STOLONIFERA (Michx.) Rydb.	Empetraceae
Cupressaceae	EMPETRUM HERMAPHRODITUM (Lange) Hagerup
JUNIPERUS COMMUNIS L.	Equisetaceae
Cyperaceae	EQUISETUM ARVENSE L.
CAREX AENEA Fern.	EQUISETUM FLUVIATILE L. ampl. Ehrh.
CAREX AQUATILIS Wahlenb.	EQUISETUM HIEMALE L.
CAREX ATHERODES Sprengel	EQUISETUM PALUSTRE L.
CAREX BIGELOWII Torrey	EQUISETUM PRATENSE Ehrh.
CAREX BONANZENSIS Britton	EQUISETUM SCIRPOIDES Michaux
CAREX BRUNNESCENS (Pers.) Poir.	EQUISETUM SILVATICUM L.
CAREX CANESCENS L.	EQUISETUM VARIEGATUM Schleicher
CAREX CAPILLARIS L.	Ericaceae
CAREX CAPITATA Sol.	ANDROMEDA POLIFOLIA L.
CAREX CHORDORRHIZA Ehrh.	ARCTOSTAPHYLOS UVA-URSI (L.) Sprengel
CAREX CONCINNA R. Br.	ARCTOUS ALPINA (L.) Niedenzu
CAREX CRAWFORDII Fern.	ARCTOUS RUBRA (Rehder & E. Wilson) Nakai
CAREX DIANDRA Schrank	CASSIOPE TETRAGONA (L.) D. Don ssp. TETRAGONA
CAREX DISPERMA Dewey	CHAMAEDAPHNE CALYCVLATA (L.) Moench
CAREX DURIUSCULA C.E. Mey.	LEDUM GROENLANDICUM Oeder
CAREX ELEUSINOIDES Turcz.	LEDUM PALUSTRE L. ssp. DECUMBENS (Aiton) Hulten
CAREX FILIFOLIA Nutt.	LOISELEURIA PROCUMBENS (L.) Desv.
CAREX GARBERI Fern. ssp. BIFARIA (Fern.) Hulten	OXYCOCCUS MICROCARPUS Turcz. ex Rupr.
CAREX KRAUSEI Boeckeler	VACCINIUM ULIGINOSUM L. ssp. ALPINUM (Bigelow) Hulten
CAREX LASIOCARPA Ehrh.	VACCINIUM VITIS-IDAEA L.
CAREX LEPTALEA Wahlenb.	Fabaceae
CAREX LIMOSA L.	ASTRAGALUS ADSURGENS Pallas ssp. VICIFOLIUS
CAREX MAGELLANICA Lam. ssp. IRRIGUA (Wahlenb.)	(Hulten) Welsh
Hulten	ASTRAGALUS ALPINUS L.
CAREX MARITIMA Gunnerus	ASTRAGALUS BODINII E. Sheldon
CAREX MEDIA R. Br.	CARAGANA ARBORESCENS Lam.
CAREX MICROCHAETA Holm ssp. MICROCHAETA	HEDYSARUM ALPINUM L. ssp. AMERICANUM (Michaux) B.
CAREX MICROCHAETA Holm ssp. NESOPHILA (Holm) D.	Fedtsch.
Murray	HEDYSARUM MACKENZII Richardson
CAREX OBTUSATA Lilj.	LUPINUS ARCTICUS S. Watson
CAREX OEDERI Retz.	MEDICAGO FALCATA L.
CAREX PECKII Howe	MEDICAGO SATIVA L.
CAREX PHYLLOMANICA W. Boott	MELILOTUS ALBUS Desrr.
CAREX PODOCARPA R. Br.	MELILOTUS OFFICINALIS (L.) Lam.
CAREX ROSSII Boott	OXYTROPIS DEFLEXA (Pallas) DC. var. FOLIOLOSA

Table C1 (cont'd).

(Hook.) Barneby	PINGUICULA VILLOSA L.
OXYTROPIS DEFLEXA (Pallas) DC. var. SERICEA Torrey & A. Gray	UTRICULARIA INTERMEDIA Hayne
OXYTROPIS TANANENSIS B. A. Yurtsev	UTRICULARIA MINOR L.
OXYTROPIS VARIANS (Rydb.) Schumann	UTRICULARIA VULGARIS L.
TRIFOLIUM HYBRIDUM L.	Liliaceae
TRIFOLIUM PRATENSE L.	TOFIELDIA COCCINEA Richardson
TRIFOLIUM REPENS L.	ZYGADENUS ELEGANS Pursh
VICIA ANGUSTIFOLIA (L.) Reichard	Linaceae
VICIA CRACCA L.	LINUM LEWISII Pursh
Fumariaceae	Lycopodiaceae
CORYDALIS AUREA Willd.	HUPERZIA SELAGO (L.) C. Martius
CORYDALIS SEMPERVIRENS (L.) Pers.	LYCOPODIUM ALPINUM L.
Gentianaceae	LYCOPODIUM ANNOTINUM L. ssp. ANNOTINUM
GENTIANA GLAUCA Pallas	LYCOPODIUM ANNOTINUM L. ssp. PUNGENS (La Pyl.) Hulten
GENTIANELLA AMARELLA (L.) Boerner	LYCOPODIUM COMPLANATUM L.
GENTIANELLA PROPINQUA (Richardson) J. M. Gillett	LYCOPODIUM OBSCURUM L.
GENTIANOPSIS DETONSA (Rottb.) Malte ssp. YUKONENSIS (J.M. Gillett) J.M. Gillett	Myricaceae
LOMATOGONIUM ROTATUM (L.) E. Fries	MYRICA GALE L.
MENYANTHES TRIFOLIATA L.	Nymphaceae
Geraniaceae	NUPHAR POLYSEPALUM Engelm.
ERODIUM CICUTARIUM (L.) L'Her.	NYMPHAEA TETRAGONA Georgi
GERANIUM BICKNELLII Britton	Onagraceae
Grossulariaceae	CIRCAEA ALPINA L.
RIBES HUDSONIANUM Richardson	EPILOBIUM ANGUSTIFOLIUM L.
RIBES LACUSTRE (Pers.) Poirer	EPILOBIUM CILIATUM Raf.
RIBES TRISTE Pallas	EPILOBIUM CILIATUM Raf. ssp. ADENOCAULON (Hausskn.) Hoch & Raven
Haloragaceae	EPILOBIUM HORNEMANNII Reichb. ssp. HORNEMANNII
HIPPURIS VULGARIS L.	EPILOBIUM LATIFOLIUM L.
MYRIOPHYLLUM SIBIRICUM Kom.	EPILOBIUM PALUSTRE L.
MYRIOPHYLLUM VERTICILLATUM L.	Ophioglossaceae
Hydrophyllaceae	BOTRYCHIUM LUNARIA (L.) Sw.
NEMOPHILA MENZIESII Hook. & Arn.	Orchidaceae
Iridaceae	CALYPSO BULBOSA (L.) Oakes
IRIS SETOSA Pallas	CORALLORRHIZA TRIFIDA Chatel.
Juncaceae	CYPRIPEDIUM GUTTATUM Sw. ssp. GUTTATUM
JUNCUS ALPINUS Villars	CYPRIPEDIUM PASSERINUM Richardson
JUNCUS ARCTICUS Willd. ssp. ALASKANUS Hulten	GOODYERA REPENS (L.) R. Br.
JUNCUS ARCTICUS Willd. ssp. ATER (Rydb.) Hulten	HAMMARBYA PALUDOSA (L.) Kuntze
JUNCUS BUFONIUS L.	LISTERA BOREALIS Morong
JUNCUS CASTANEUS Smith ssp. CASTANEUS	PLATANThERA HYPERBOREA (L.) Lindley
JUNCUS CASTANEUS Smith ssp. LEUCOCHLAMYS (I. Zinserl.) Hulten	PLATANThERA OBTUSATA (Pursh) Lindley
JUNCUS FILIFORMIS L.	SPIRANTHES ROMANZOFFIANA Cham.
JUNCUS STYGIUS L.	Orobanchaceae
JUNCUS TRIGLUMIS L. ssp. ALBESCENS (Lange) Hulten	BOSCHNIAKIA ROSSICA (Cham. & Schldl.) B. Fedtsch.
LUZULA CONFUSA Lindeb.	Papaveraceae
LUZULA KJELLMANIANA Miyabe & Kudo	ESCHSCHOLZIA CALIFORNICA Cham.
LUZULA MULTIFLORA (Retz.) Lej.	Pinaceae
LUZULA PARVIFLORA (Ehrh.) Desv.	LARIX LARICINA (Du Roi) K. Koch
LUZULA RUFESCENS Fischer	PICEA GLAUCA (Moench) Voss
Juncaginaceae	PICEA MARIANA (Miller) Britton, Sterns, Pogg.
TRIGLOCHIN MARITIMUM L.	Plantaginaceae
TRIGLOCHIN PALUSTRIS L.	PLANTAGO MAJOR L. var. MAJOR
Lamiaceae	Poaceae
DRACOCEPHALUM PARVIFLORUM Nutt.	AGROSTIS SCABRA Willd.
GALEOPSIS BIFIDA Boenn.	ALOPECURUS AEQUALIS Sobol.
LYCOPUS UNIFLORUS Michaux	ALOPECURUS ALPINUS Smith
SCUTELLARIA GALERICULATA L.	ALOPECURUS PRATENSIS L.
STACHYS PALUSTRIS L. ssp. PILOSA (Nutt.) Epling	ARCTAGROSTIS LATIFOLIA (R. Br.) Griseb. var. ARUNDINACEA (Trin.) Griseb.
Lemnaceae	ARCTOPHILA FULVA (Trin.) Andersson
LEMNA MINOR L.	AVENA FATUA L.
LEMNA TRISULCA L.	BECKMANNIA ERUCAEFORMIS (L.) Host
Lentibulariaceae	BROMOPSIS INERMIS (Leysser) Holub
	BROMOPSIS PUMPELLIANA (Scribner) Holub ssp. PUMPELLIANA

**Table C1 (cont'd). Checklist of collected vascular plants arranged by family from Fort Wainwright Military Installation, Alaska, 1995 (from Racine et al. 1997). Nomenclature follows that used by the University of Alaska Museum.**

CALAMAGROSTIS CANADENSIS (Michaux) P. Beauv.	POTAMOGETON PECTINATUS L.
CALAMAGROSTIS INEXPANSA A. Gray	POTAMOGETON PRAELONGUS Wulfen
CALAMAGROSTIS LAPPONICA (Wahlenb.) Hartman F.	POTAMOGETON PUSILLUS L. var. TENUISSIMUS Mert. & Koch
CALAMAGROSTIS NEGLECTA (Ehrh.) Gaertner	POTAMOGETON RICHARDSONII (A. Bennett) Rydb.
CALAMAGROSTIS PURPURASCENS R. Br.	POTAMOGETON VAGINATUS Turcz.
DESCHAMPSIA CESPITOSA (L.) P. Beauv.	POTAMOGETON ZOSTERIFORMIS Fernald
ELYMUS ALASKANUS (Scribner & Merr.) A. Loeve ssp. BO-	Primulaceae
REALIS (Turcz.) A. Loeve & D. Loeve	ANDROSACE SEPTENTRIONALIS L.
ELYMUS MACROURUS (Turcz.) Tzvelev	DODECATHEON PULCHELLUM (Raf.) Merr. ssp.
ELYMUS SUBSECUNDUS (Link) A. Loeve & D. Loeve	PAUCIFLORUM (E. Greene) Hulten
ELYMUS TRACHYCAULUS (Link) Gould ex Shinners	LYSIMACHIA THYRSIFLORA L.
ELYMUS TRACHYCAULUS (Link) Gould ex Shinners ssp.	PRIMULA INCANA M. E. Jones
TRACHYCAULUS	TRIENTALIS EUROPAEA L. ssp. ARCTICA (Fischer) Hulten
ELYMUS TRACHYCAULUS (Link) Gould ex Shinners ssp.	Pyrolaceae
VIOLACEUS (Hornem.) A. Loeve & D. Loeve	MONESSES UNIFLORA (L.) A. Gray
ELYTRIGIA REPENS (L.) Nevski	ORTHILIA SECUNDA (L.) House
ELYTRIGIA SPICATA (Pursh) D. R. Dewey	ORTHILIA SECUNDA (L.) House ssp. OBTUSATA (Turcz.) Bocher
FESTUCA ALTAICA Trin.	PYROLA ASARIFOLIA Michaux
FESTUCA BRACHYPHYLLA Schultes & Schultes F.	PYROLA CHLORANTHA Sw.
FESTUCA LENENSIS Drobov	PYROLA GRANDIFLORA Radius
FESTUCA SAXIMONTANA Rydb.	Ranunculaceae
GLYCERIA BOREALIS (Nash) Batch.	ACONITUM DELPHINIFOLIUM DC.
GLYCERIA MAXIMA (Hartman F.) O. Holmb.	ACTAEA RUBRA (Aiton) Willd.
GLYCERIA PULCHELLA (Nash) Schum.	ANEMONE NARCISSIFLORA L. var. MONANTHA DC.
HIEROCHLOE ALPINA (Sw.) Roemer & Schultes	ANEMONE PARVIFLORA Michaux
HIEROCHLOE ODORATA (L.) P. Beauv.	ANEMONE RICHARDSONII Hook.
HORDEUM BRACHYANTHERUM Nevski	AQUILEGIA BREVI-STYLA Hook.
HORDEUM JUBATUM L.	CALTHA NATANS Pallas
LEYMUS INNOVATUS (Beal) Pilger	CALTHA PALUSTRIS L.
LOLIUM MULTIFLORUM Lam.	CONSOLIDA AMBIQUA (L.) P. Bass & Heyw.
PHLEUM PRATENSE L.	DELPHINIUM GLAUCUM S. Watson
POA ALPINA L.	PULSATILLA PATENS (L.) Miller
POA ANNUA L.	RANUNCULUS GMELINII DC.
POA ARCTICA R. Br.	RANUNCULUS HYPERBOREUS Rottb.
POA GLAUCA M. Vahl	RANUNCULUS LAPPONICUS L.
POA PALUSTRIS L.	RANUNCULUS MACOUNII Britton
POA PRATENSIS L.	RANUNCULUS PENNSYLVANICUS L. F.
PUCCINELLIA BOREALIS Swallen	RANUNCULUS REPTANS L.
PUCCINELLIA T. Sorensen	RANUNCULUS SCELERATUS L. ssp. MULTIFIDUS (Nutt.)
TRISETUM SPICATUM (L.) K. Richter	Hulten
Polemoniaceae	RANUNCULUS TRICHOPHYLLUS Chaix
COLLOMIA LINEARIS Nutt.	THALICTRUM SPARSIFLORUM Turcz.
POLEMONIUM ACUTIFLORUM Willd.	Rosaceae
Polygonaceae	AMELANCHIER ALNIFOLIA (Nutt.) Nutt.
BISTORTA PLUMOSA (Small) E. Greene	COMARUM PALUSTRE L.
BISTORTA VIVIPARA (L.) Gray	DRYAS DRUMMONDII Richardson
POLYGONUM ALASKANUM (Small) W. Wight	DRYAS OCTOPETALA L. var. OCTOPETALA
POLYGONUM AMPHIBIUM L.	FRAGARIA VIRGINIANA Duchesne
POLYGONUM AVICULARE L.	GEUM PERINCISUM Rydb.
POLYGONUM CONVULVULUS L.	PENTAPHYLLOIDES FLORIBUNDA (Pursh) A. Loeve
POLYGONUM LAPATHIFOLIUM L.	POTENTILLA ARGUTA Pursh
POLYGONUM PENNSYLVANICUM L. ssp. ONEILLII	POTENTILLA EGEDII Wormsk.
(Brenckle) Hulten	POTENTILLA HOOKERIANA Lehm.
RUMEX ARCTICUS Trautv.	POTENTILLA MULTIFIDA L.
RUMEX FENESTRATUS E. Greene	POTENTILLA NORVEGICA L.
RUMEX MEXICANUS Meissner	POTENTILLA PENNSYLVANICA L.
RUMEX SIBIRICUS Hulten	POTENTILLA UNIFLORA Ledeb.
Polypodiaceae	POTENTILLA VIRGULATA Nelson
POLYPODIUM VULGARE L. ssp. COLUMBIANUM (Gilbert)	ROSA ACICULARIS Lindley
Hulten	ROSA WOODSII Lindley
Potamogetonaceae	RUBUS ARCTICUS L. ssp. ARCTICUS
POTAMOGETON ALPINUS Balbis	RUBUS CHAMAEMORUS L.
POTAMOGETON EPIHYDRUS Raf.	RUBUS IDAEUS L.
POTAMOGETON FILIFORMIS Pers.	SANGUISORBA OFFICINALIS L.
POTAMOGETON FRIESII Rupr.	SORBUS SCOPULINA E. Greene
POTAMOGETON GRAMINEUS L.	SPIRAEA STEVENII (C. Schneider) Rydb.

Table C1 (cont'd).

Rubiaceae

GALIAM BOREALE L.  
 GALIAM BRANDEGEI A. Gray  
 GALIAM TRIFIDUM L. ssp. TRIFIDUM  
 GALIAM TRIFLORUM Michaux

Salicaceae

POPULUS BALSAMIFERA L. ssp. BALSAMIFERA  
 POPULUS TREMULOIDES Michaux  
 SALIX ALAXENSIS (Andersson) Cov. var. LONGISTYLIS (Rydb.)  
 C. Schneider  
 SALIX ARBUSCULOIDES Andersson  
 SALIX ARCTICA Pallas  
 SALIX BEBBIANA Sarg.  
 SALIX BRACHYCARPA Nutt.  
 SALIX BRACHYCARPA Nutt. ssp. NIPHOCLADA (Rydb.) Argus  
 SALIX FUSCESCENS Andersson  
 SALIX GLAUCA L.  
 SALIX GLAUCA L. var. ACUTIFOLIA (Andersson) C. Schneider  
 SALIX HASTATA L.  
 SALIX Rowlee  
 SALIX LUCIDA Muhl. ssp. LASIANDRA (Benth.) Argus  
 SALIX MYRTILLIFOLIA Andersson  
 SALIX NOVAE-ANGLIAE Andersson  
 SALIX PHLEBOPHYLLA Andersson  
 SALIX PLANIFOLIA Pursh  
 SALIX PLANIFOLIA Pursh ssp. PULCHRA (Cham.) Argus  
 SALIX PSEUDOMONTICOLA C. Ball  
 SALIX SCOULERIANA J. Barratt

Santalaceae

GEOCAULON LIVIDUM (Richardson) Fern.

Saxifragaceae

CHRYSOSPLENIUM TETRANDRUM (N. Lund) T. C. E. Fries  
 PARNASSIA PALUSTRIS L.  
 SAXIFRAGA CERNUA L.

SAXIFRAGA NELSONIANA D. Don

SAXIFRAGA REFLEXA Hook.

SAXIFRAGA TRICUSPIDATA Rottb.

Scrophulariaceae

CASTILLEJA CAUDATA (Pennell) Rebrist.  
 CASTILLEJA ELEGANS Malte  
 EUPHRASIA DISJUNCTA Fern. & Wieg.  
 LINARIA VULGARIS Miller  
 PEDICULARIS CAPITATA J. Adams  
 PEDICULARIS LABRADORICA Wirs.  
 PEDICULARIS LANATA Cham. & Schldl.  
 PEDICULARIS LANGSDORFFII Fischer ex Steven  
 PEDICULARIS MACRODONTA Richardson  
 RHINANTHUS MINOR L.  
 SYNTHYRIS BOREALIS Pennell  
 VERONICA SCUTELLATA L.

Selaginellaceae

SELAGINELLA SIBIRICA (Milde) Hieron.

Sparganiaceae

SPARGANIUM ANGUSTIFOLIUM Michaux  
 SPARGANIUM HYPERBOREUM Laest.  
 SPARGANIUM MINIMUM (Hartman F.) Fries

Typhaceae

TYPHA LATIFOLIA L.

Urticaceae

URTICA DIOICA L. ssp. GRACILIS (Aiton) Selander

Valerianaceae

VALERIANA CAPITATA Pallas

Violaceae

VIOLA BIFLORA L.  
 VIOLA EPIPSILA Ledeb.  
 VIOLA RENIFOLIA A. Gray  
 VIOLA TRICOLOR L.

**Table C2. Alphabetical checklist of identified common ground cover cryptogams collected on Ft. Wainwright Alaska during 1995 (from Racine et al. 1997). Genus names represent specimens identified to genus but not yet identified to species. \* refers to a lichenicolous fungus.**

## **LICHENS**

Alectoria ochroleuca (Hoffm.) A.Massal.  
 Anamylopsora pulcherrima (Vain.) Timdal  
 Arctoparmelia separata (Th.Fr.) Hale  
 Asahinea chrysantha (Tuck.) W.L.Culb. & C.F.Culb.  
 Asahinea scholanderi (Llano) W.L.Culb. & C.F.Culb.  
 Baeomyces rufus (Huds.) Rebert.  
 Brodoa oroarctica (Krog) Goward  
 Bryocaulon divergens (Ach.) Kärnefelt  
 Bryoria lanestris (Ach.) Brodo & D.Hawksw.  
 Bryoria nitidula (Th.Fr.) Brodo & D.Hawksw.  
 Cetraria aculeata (Schreb.) Fr.  
 Cetraria islandica (L.) Ach.  
 Cetraria laevigata Rass.  
 Cetraria muricata (Ach.) Eckfeldt  
 Cetraria nigricans Nyl.  
 Chaenotheca stemonea (Ach.) Müll.Arg.  
 Cladina aberrans (Abbayes) Hale & W.L.Culb.  
 Cladina arbuscula (Wallr.) Hale & W.L.Culb.  
 Cladina rangiferina (L.) Nyl.  
 Cladina stellaris (Opiz) Brodo  
 Cladonia amaurocraea (Flörke) Schaer.  
 Cladonia borealis S.Stenroos  
 Cladonia cariosa (Ach.) Spreng.  
 Cladonia cenotea (Ach.) Schaer.  
 Cladonia coccifera (L.) Willd.  
 Cladonia cornuta (L.) Hoffm.  
 Cladonia cornuta (L.) Hoffm. subsp. cornuta  
 Cladonia crispata (Ach.) Flot.  
 Cladonia deformis (L.) Hoffm.  
 Cladonia fimbriata (L.) Fr.  
 Cladonia furcata (Huds.) Schrad.  
 Cladonia gracilis (L.) Willd.  
 Cladonia gracilis (L.) Willd. subsp. gracilis  
 Cladonia gracilis (L.) Willd. subsp. turbinata (Ach.) Ahti  
 Cladonia kanewskii Oksner  
 Cladonia phyllophora Ehrh. ex Hoffm.  
 Cladonia pleurota (Flörke) Schaer.  
 Cladonia pocillum (Ach.) Grognot  
 Cladonia scabriuscula (Delise) Nyl.  
 Cladonia singularis S.Hammer  
 Cladonia uncialis (L.) Weber ex F.H.Wigg.  
 Dactylina arctica (Richardson) Nyl.  
 Dibaeis baeomyces (L.f.) Rambold & Hertel  
 Epilichen scabrosus\* (Ach.) Clem. ex Hafellner  
 Flavocetraria cucullata (Bellardi) Kärnefelt & Thell  
 Flavocetraria nivalis (L.) Kärnefelt & Thell subsp. nivalis  
 Hypogymnia  
 Hypogymnia austerodes (Nyl.) Räsänen  
 Hypogymnia physodes (L.) Nyl.  
 Hypogymnia subobscura (Vain.) Poelt  
 Icmadophila ericetorum (L.) Zahlbr.  
 Lasallia pensylvanica (Hoffm.) Llano  
 Lobaria linita (Ach.) Rabenh.  
 Lobaria linita (Ach.) Rabenh. var. linita  
 Lobaria scrobiculata (Scop.) DC. in Lam. & DC.  
 Lopadium pezizoideum (Ach.) Körb.  
 Masonhalea richardsonii (Hook.) Kärnefelt  
 Melanelia granulosa (Lynge) Essl.  
 Melanelia hepatizon (Ach.) Thell  
 Nephroma arcticum (L.) Torss.  
 Nephroma bellum (Spreng.) Tuck.  
 Nephroma expallidum (Nyl.) Nyl.  
 Nephroma parile (Ach.) Ach.  
 Nephroma resupinatum (L.) Ach.  
 Ochrolechia upsaliensis (L.) A.Massal.

Ophioparma lapponica (Räsänen) Hafellner & R.W.Rogers  
 Pannaria pezizoides (Weber) Trevis.  
 Parmelia fraudans (Nyl.) Nyl.  
 Parmelia omphalodes (L.) Ach.  
 Parmelia panniformis (Nyl.) Vain.  
 Parmelia saxatilis (L.) Ach.  
 Parmelia sulcata Taylor  
 Peltigera aphthosa (L.) Willd.  
 Peltigera canina (L.) Willd.  
 Peltigera collina (Ach.) Schrad.  
 Peltigera didactyla (With.) J.R.Laundon  
 Peltigera didactyla (With.) J.R.Laundon var. didactyla  
 Peltigera didactyla (With.) J.R.Laundon var. extenuata (Nyl. ex Vain.) Goffinet & Hastings  
 Peltigera elisabethae Gyeln.  
 Peltigera lepidophora (Nyl. ex Vain.) Bitter  
 Peltigera leucophlebia (Nyl.) Gyeln.  
 Peltigera malacea (Ach.) Funck  
 Peltigera polydactyla aggregate  
 Peltigera praetextata (Flörke ex Sommerf.) Zopf  
 Peltigera retifoveata Vitik.  
 Peltigera rufescens (Weiss) Humb.  
 Peltigera scabrosa Th.Fr.  
 Peltigera venosa (L.) Hoffm.  
 Pertusaria subobducens Nyl.  
 Phaeophyscia  
 Phaeophyscia constipata (Norrl. & Nyl.) Moberg  
 Phaeophyscia kairamoi (Vain.) Moberg  
 Phaeophyscia sciastra (Ach.) Moberg  
 Phaeorrhiza nimbosa (Fr.) H.Mayrhofer & Poelt  
 Physconia isidiigera (Zahlbr.) Essl.  
 Physconia muscigena (Ach.) Poelt  
 Physconia perisidiosa (Erichsen) Moberg  
 Polychidium muscicola (Sw.) Gray  
 Psoroma hypnorum (Vahl) Gray  
 Psorula rufonigra (Tuck.) Gotth.Schneid.  
 Rhizoplaca chrysoleuca (Sm.) Zopf  
 Schadonia fecunda (Th.Fr.) Vezda & Poelt  
 Solorina crocea (L.) Ach.  
 Sphaerophorus fragilis (L.) Pers.  
 Sphaerophorus globosus (Huds.) Vain.  
 Sphaerophorus globosus (Huds.) Vain. var. globosus  
 Stereocaulon alpinum Laurer ex Funck  
 Stereocaulon coniophyllum I.M.Lamb  
 Stereocaulon glareosum (Savicz) H.Magn.  
 Stereocaulon pascheum (L.) Hoffm.  
 Stereocaulon subcoralloides (Nyl.) Nyl.  
 Thamnia vermicularis (Sw.) Ach. ex Schaer.  
 Tuckermannopsis americana (Spreng.) Hale  
 Umbilicaria deusta (L.) Baumg.  
 Umbilicaria vellea (L.) Ach.  
 Vulpicida pinastri (Scop.) Mattson & M.J.Lai  
 Vulpicida tilesii (Ach.) Mattson & M.J.Lai

## **HEPATIC**

Aneura pinguis (L.) Dumort.  
 Asterella saccata (Wahlenb.) A.Evans  
 Blepharostoma trichophyllum (L.) Dumort.  
 Conocephalum conicum (L.) Underw.  
 Marchantia aquatica (Nees) Burgeff  
 Marchantia polymorpha L.  
 Preissia quadrata (Scop.) Nees  
 Ptilidium ciliare (L.) Hampe  
 Riccia fluitans L.  
 Ricciocarpos natans (L.) Corda  
 Tetralophozia setiformis (Ehrh.) Schljakov

Table C2 (cont'd).

**MOSSES**

<i>Abietinella abietina</i> (Hedw.) M.Fleisch.	<i>Polytrichum commune</i> Hedw.
<i>Aloina brevirostris</i> (Hook. & Grev.) Kindb.	<i>Polytrichum hyperboreum</i> R.Br.
<i>Andreaea rupestris</i> Hedw.	<i>Polytrichum juniperinum</i> Hedw.
<i>Andreaea rupestris</i> Hedw. var. <i>rupestris</i>	<i>Polytrichum piliferum</i> Hedw.
<i>Aongstroemia longipes</i> (Sommerf.) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel	<i>Polytrichum strictum</i> Brid.
<i>Aulacomnium palustre</i> (Hedw.) Schwägr.	<i>Pseudobryum cinclidioides</i> (Huebener) T.Kop.
<i>Aulacomnium turgidum</i> (Wahlenb.) Schwägr.	<i>Psilopilum cavifolium</i> (Wilson) I.Hagen
<i>Bartramia ithyphylla</i> Brid.	<i>Pterygoneurum subsessile</i> (Brid.) Jur.
<i>Bryoerythrophyllum recurvirostrum</i> (Hedw.) P.C.Chen	<i>Ptilium crista-castrensis</i> (Hedw.) De Not.
<i>Bryum argenteum</i> Hedw.	<i>Pylaisiella polyantha</i> (Hedw.) Grout
<i>Bryum pseudotriquetrum</i> (Hedw.) P.Gaertn. , B.Mey. & Scherb.	<i>Racomitrium ericoides</i> (F.Weber ex Brid.) Brid.
<i>Calliergon cordifolium</i> (Hedw.) Kindb.	<i>Racomitrium lanuginosum</i> (Hedw.) Brid.
<i>Calliergon giganteum</i> (Schimp.) Kindb.	<i>Rhizomnium punctatum</i> (Hedw.) T.Kop.
<i>Calliergon richardsonii</i> (Mitt.) Kindb.	<i>Rhytidiadelphus triquetrus</i> (Hedw.) Warnst.
<i>Calliergon stramineum</i> (Brid.) Kindb.	<i>Rhytidium rugosum</i> (Hedw.) Kindb.
<i>Catoscopium nigrum</i> (Hedw.) Brid.	<i>Sanionia uncinata</i> (Hedw.) Loeske
<i>Ceratodon purpureus</i> (Hedw.) Brid.	<i>Schistidium apocarpum</i> (Hedw.) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel
<i>Ceratodon purpureus</i> (Hedw.) Brid. var. <i>purpureus</i>	<i>Scorpidium cossonii</i> (Schimp.) Hedenäs
<i>Climacium dendroides</i> (Hedw.) F.Weber & D.Mohr	<i>Scorpidium scorpioides</i> (Hedw.) Limpr.
<i>Conostomum tetragonum</i> (Hedw.) Lindb.	<i>Sphagnum angustifolium</i> (C.E.O.Jensen ex Russow) C.E.O.Jensen in Tolf
<i>Dicranoweisia crispula</i> (Hedw.) Lindb. ex Milde	<i>Sphagnum fimbriatum</i> Wilson in Wilson & Hook.f. in Hook.f.
<i>Dicranum polysetum</i> Sw.	<i>Sphagnum fuscum</i> (Schimp.) H.Klinggr.
<i>Dicranum undulatum</i> Brid.	<i>Sphagnum girgensohnii</i> Russow
<i>Distichium capillaceum</i> (Hedw.) Bruch & Schimp.	<i>Sphagnum lindbergii</i> Schimp. in Lindb.
<i>Drepanocladus exannulatus</i> (Schimp. in Bruch, Schimp. & W.Gümbel) Warnst.	<i>Sphagnum magellanicum</i> Brid.
<i>Encalypta brevicolla</i> (Bruch & Schimp. in Bruch, Schimp. & W.Gümbel) Bruch ex Ångstr.	<i>Sphagnum platyphyllum</i> (Lindb. ex Braithw.) Sull. ex Warnst.
<i>Encalypta ciliata</i> Hedw.	<i>Sphagnum riparium</i> Ångstr.
<i>Encalypta raptocarpa</i> Schwägr.	<i>Sphagnum rubellum</i> Wilson
<i>Funaria hygrometrica</i> Hedw.	<i>Sphagnum russowii</i> Warnst.
<i>Grimmia torquata</i> Hornsch. in Grev.	<i>Sphagnum squarrosum</i> Crome
<i>Hamatocaulis vernicosus</i> (Mitt.) Hedenäs	<i>Sphagnum teres</i> (Schimp.) Ångstr.
<i>Hedwigia ciliata</i> (Hedw.) P.Beauv.	<i>Sphagnum warnstorffii</i> Russow
<i>Helodium blandowii</i> (F.Weber & D.Mohr) Warnst.	<i>Splachnum ampullaceum</i>
<i>Hylacomium splendens</i> (Hedw.) Schimp. in Bruch, Schimp. & W.Gümbel	<i>Splachnum luteum</i> Hedw.
<i>Leptobryum pyriforme</i> (Hedw.) Wilson	<i>Splachnum melanocaulon</i> (Wahlenb.) Schwägr.
<i>Meesia uliginosa</i> Hedw.	<i>Splachnum rubrum</i> Hedw.
<i>Oncophorus virens</i> (Hedw.) Brid.	<i>Splachnum sphaericum</i> Hedw.
<i>Orthotrichum obtusifolium</i> Brid.	<i>Syntrichia ruralis</i> (Hedw.) F. Weber & D. Mohr
<i>Plagiomnium cuspidatum</i> (Hedw.) T.Kop.	<i>Tetraplodon mnioides</i> (Hedw.) Bruch & Schimp. in Bruch, Schimp. & W.Gümbel
<i>Plagiomnium rugicum</i> (Laurer) T.Kop.	<i>Thuidium recognitum</i> (Hedw.) Lindb.
<i>Pleurozium schreberi</i> (Brid.) Mitt.	<i>Timmia austriaca</i> Hedw.
<i>Pogonatum dentatum</i> (Brid.) Brid.	<i>Timmia megapolitana</i> Hedw.
<i>Pohlia andalusica</i> (Hoehnel) Broth.	<i>Tomentypnum nitens</i> (Hedw.) Loeske
<i>Pohlia cruda</i> (Hedw.) Lindb.	<i>Tortella fragilis</i> (Drumm.) Limpr.
<i>Pohlia prolifera</i> (Lindb. ex Breidl.) Lindb. ex Arnell	<i>Tortula acaulon</i> (L. ex With.) R.H.Zander
<i>Polytrichastrum longisetum</i> (Brid.) G.L.Sm.	<i>Tortula mucronifolia</i> Schwägr.

Form Approved  
OMB No. 0704-0188

**1. AGENCY USE ONLY (Leave blank)**

### 3. REPORT TYPE AND DATES COVERED

#### 4. TITLE AND SUBTITLE

## 5. FUNDING NUMBERS

## 6. AUTHORS

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**

U.S. Army Cold Regions Research and  
Engineering Laboratory  
72 Lyme Road  
Hanover, New Hampshire 03755-1290

8. PERFORMING ORGANIZATION  
REPORT NUMBER

CRREL Report 99-9

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

U.S. Army, Alaska  
Fort Richardson, Alaska 99505

10. SPONSORING/MONITORING  
AGENCY REPORT NUMBER

## 11. SUPPLEMENTARY NOTES

For conversion of SI units to non-SI units of measurement, consult ASTM Standard E380-93, *Standard Practice for Use of the International System of Units*, published by the American Society for Testing and Materials, 100 Barr Harbor Drive., West Conshohocken, Pennsylvania 19428-2959.

### 12a. DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

Available from NTIS, Springfield, Virginia 22161

12b. DISTRIBUTION CODE

**13. ABSTRACT** (*Maximum 200 words*)

An ecological land survey (ELS) of Fort Wainwright land was conducted to map ecosystems at three spatial scales to aid in the management of natural resources. In an ELS, an attempt is made to view landscapes not just as aggregations of separate biological and earth resources, but as ecological systems with functionally related parts that can provide a consistent conceptual framework for ecological applications. Field surveys at 109 sites along 11 toposequences, and at an additional 131 ground-reference locations, were used to identify relationships among physiography, geomorphology, hydrology, permafrost, and vegetation. The association among ecosystem components also revealed effects of fire and geomorphic processes, such as groundwater discharge, floodplain development, permafrost degradation, and paludification. Ecosystems were mapped at three spatial scales. Ecotypes (1:50,000 scale), delineated areas with homogenous topography, terrain, soil, surface-form, hydrology, and vegetation. Ecosections (1:100,000 scale) are homogeneous with respect to geomorphic features and water regime and, thus, have recurring patterns of soils and vegetation. Ecodistricts (1:500,000) are broader areas with similar geology, geomorphology, and physiography. Development of the spatial database within a geographic information system will facilitate numerous management objectives such as wetland protection, integrated-training-area management, permafrost protection, wildlife management, and recreational area management.

#### 14. SUBJECT TERMS

## Ecosystem mapping Fort Wainwright, Alaska

## Land survey

## Vegetation

15. NUMBER OF PAGES  
92

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT  
 UNCLASSIFIED

UNCLASSIFIED

18. SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED

19. SECURITY CLASSIFICATION  
OF ABSTRACT

UNCLASSIFIED

## 20. LIMITATION OF ABSTRACT

UL